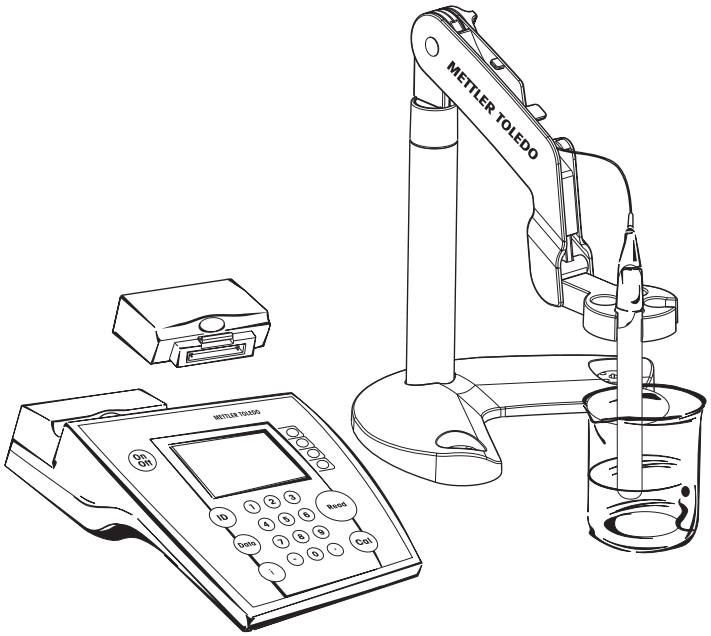
Operating Instructions



SevenMulti

METTLER TOLEDO

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1. SevenMulti™

1.1 Introduction

SevenMulti™ – Modular expansion at any time

An ingenious instrument concept based on precise electrochemical measuring technique combined with latest options for your challenges in the laboratory.

- Extend the instrument's possibilities with durable plug-in expansion units at any time. With no effort, make it a dual channel instrument.
- Control a sample changer or operate the SevenMulti™ using a computer software program.

1.2 Safety precautions

Measures for your protection

– Never work in an environment subject to explosion hazards! The housing of the instrument is not gas tight (explosion hazard due to spark formation, corrosion caused by the ingress of gases).

– When using chemicals and solvents, comply with the instructions of the producer and the general lab safety rules!

Measures for operational safety

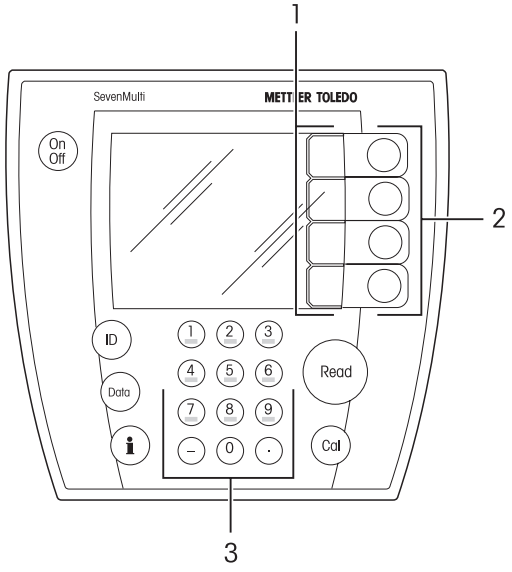
– Have the instrument serviced only by METTLER TOLEDO Service!

– Dry off any liquids sprayed immediately! The instrument is not watertight.

– Exclude the following environmental influences:
  - powerful vibrations,
  - direct sunlight,
  - atmospheric humidity greater than 80%,
  - corrosive gas atmosphere,
  - temperatures below 5 °C and above 40 °C,
  - powerful electric or magnetic fields!

1.3 Description of the instrument

1.3.1 Key field



- On Off — Switches SevenMulti™ on/off
- ID — Activates the input of sample, sensor or user IDs
- Data — Saves, displays, sends and deletes data
- i — Opens the i menu, provides context-sensitive help
- Cal — Starts calibration
- Read — Starts/ends reading

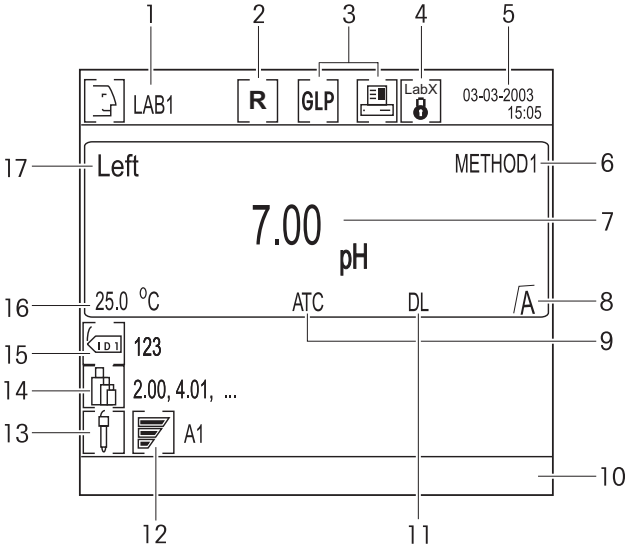
1 Softkey assignment (variable)

2 The current softkey assignment is shown to the left on the screen

3 Alphanumeric key field

1.3.2 Symbols in the measurement display

In addition to the measured value, additional symbols and messages appear on the screen, which allow you to check the measurement process for each expansion unit.



1 User name

2 Routine mode active

3 GLP printout active/ data transfer to printer/PC active

4 Interface settings: LabX

5 Date and time

6 Selected method

7 Measured value with unit

8 Endpoint
A automatic, M manual, T timed

9 ATC or MTC – automatic or manual temperature compensation

10 Information line, e.g. for the calibration reminder

11 Timed Interval Reading active

12 Condition of the attached electrode (pH)
- Electrode in good condition
- Electrode requires cleaning
- Electrode is defective

13 Sensor ID

14 Calibration standards

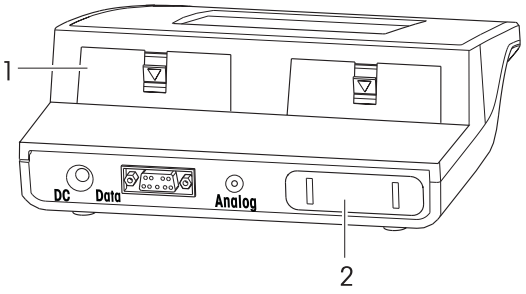
15 Sample ID

16 Measured/specified temperature

17 Selected channel

1.3.3 Connections

Connections on the SevenMulti™



DC Mains connection socket

Data RS232 interface

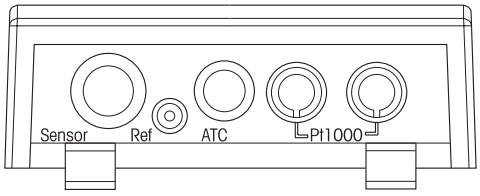
Analog Analog output of electrode potential for pH/Ion expansion unit

1 2 connections for expansion units

2 1 connection for communication modules

The expansion units can be combined together as you wish, with one **exception**: It is not possible to have 2 Conductivity expansion units.

Connections on the pH and Ion expansion unit



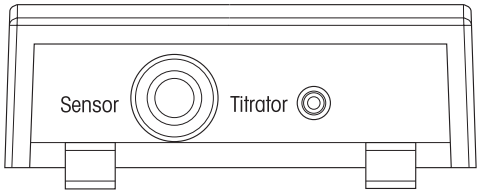
Sensor Electrode connection socket

Ref Reference electrode connection socket

ATC Connection for temperature sensor NTC 30 kΩ

Pt1000 Connection for temperature sensor Pt1000

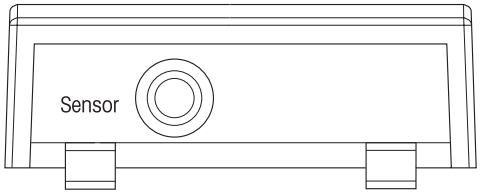
Connections on the Conductivity expansion unit



Sensor Electrode connection socket

Titrator Titration unit output (analog signal)

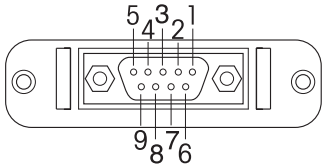
Connections on the ISFET expansion unit



Sensor Electrode connection socket

1.3.4 Pin assignments

RS232, TTL: Socket 9 Pin, D-Sub, female



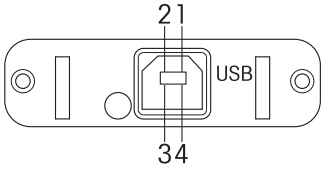
Pin assignment RS232

Pin 1	NC	Pin 6	NC
Pin 2	TxD (out)	Pin 7	NC
Pin 3	RxD (in)	Pin 8	NC
Pin 4	NC	Pin 9	NC
Pin 5	RSGND		

Pin assignment TTL

Pin 1	In 1	Pin 6	Out 4
Pin 2	In 2	Pin 7	Ground
Pin 3	Out 1	Pin 8	Ground
Pin 4	Out 2	Pin 9	+5 Volt
Pin 5	NC		

USB



Pin assignment USB

Pin 1	VCC
Pin 2	D–
Pin 3	D+
Pin 4	Ground

1.4 Analog output

For the pH and Ion expansion units the analog output of the SevenMulti™ supplies a voltage proportional to the displayed measured value (pH, mV, rel. mV and ion concentration). The polarity of the output corresponds to the polarity at the measurement electrode. The voltage at the analog output is not temperature-compensated.

- If a pH or Ion expansion unit is operated on both channels, the measurement signal of the expansion unit on the left channel is always output at the analog ouput.
- This analog output does not supply voltage for the Conductivity and ISFET expansion units.

1.5 Maintenance

1.5.1 Cleaning the SevenMulti™

– The housing is made of ABS/PC, which could be damaged by certain organic solutions such as Toluene, Xylene and methyl ethyl ketone. Good laboratory conduct requires immediate wiping out of emptied spilled.

Safety precaution

– The housing and power supply may not be opened!

1.5.2 Cleaning the electrodes

The SevenMulti™ monitors the condition of the attached pH electrodes.

- Electrode in good condition
  for pH: slope 95 to 105 %, offset -15 to + 15 mV
  for ISFET: slope 85 to 105 %, offset - 15 to + 15 mV

- Electrode must be cleaned
  for pH: slope 90 to 94 %, offset - 15 to - 35 mV and + 15 to + 35 mV
  for ISFET: slope 80 to 84 %, offset - 15 to - 35 mV and + 15 to + 35 mV

- Electrode is defective
  for pH: slope 85 to 89 %, offset < - 35 mV and offset > + 35 mV
  for ISFET: slope 75 to 79 %, offset < - 35 mV and offset > + 35 mV

– When cleaning, always comply with the information contained in the operating instructions of the electrodes used.
– The condition of the pH electrode can also be checked using the electrode test provided.

1.5.3 Disposal

In conformance with the European Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE) this device may not be disposed of in domestic waste.
This also applies to countries outside the EU, per their specific requirements.
Please dispose of this product in accordance with local regulations at the collecting point specified for electrical and electronic equipment.
If you have any questions, please contact the responsible authority or the distributor from which you purchased this device.
Should this device be passed on to other parties (for private or professional use), the content of this regulation must also be related.
Thank you for your contribution to environmental protection.

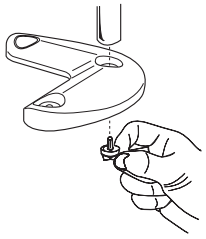
2. Installation

2.1 Unpacking/checking scope of delivery

– Unpack the instrument and check the scope of delivery with the accompanying shipping list.

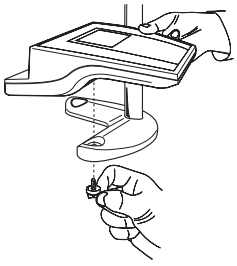
2.2 Mounting electrode arm

The electrode arm can be used standalone or mounted to SevenMulti™.
The base offers 3 different positions for mounting of the electrode arm.



Mounting electrode arm as standalone

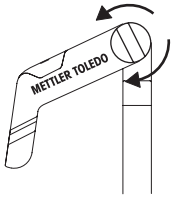
– Remove the cover from the central hole in the base.
– Place the electrode arm into the holder and secure the connection with the supplied mountingscrew.
– Save the cover in case you would like to mount the electrode arm in a different position at a later time.



Mounting electrode arm to SevenMulti™

The electrode arm can be fastened to SevenMulti™ on the left or right side.

– Remove the cover from two holes in the base.
– Mount the base to the instrument with the supplied mounting screw so that the free end of the base points toward the rear.
– Place the electrode arm into the holder and secure the connection with the supplied mountingscrew.



Adjusting electrode arm

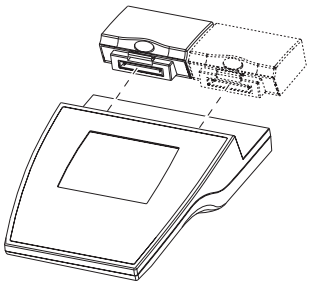
The position of the electrode arm can be adjusted with the rotary tensioning knob.

– To loosen the rotary tensioning knob: turn the knob anticlockwise.
– To tighten the rotary tensioning knob: turn the knob clockwise.

2.3 Installing/removing expansion units

SevenMulti™ can be equipped with 2 expansion units. The expansion units can be combined together as you wish, with one **exception**: It is not possible to have 2 Conductivity expansion units.
If you are only working with one expansion unit, you can equip the free connection with a blank expansion unit (Order No. 51302874).
Please note that you must first switch off the instrument and then switch it on again if you change the expansion unit during operation.

.



Installing expansion unit

– Remove the cover from the desired slot (left or right).
– Save the cover.
– Insert the expansion unit into the slot until it engages.

Removing expansion unit

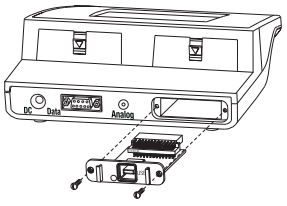
– Press the coloured button on the expansion unit and remove it from the instrument.
– If you do not wish to insert another expansion unit into this slot, replace the cover or use a blank expansion unit.

2.4 Installing/removing communication module

Safety precaution

– Switch off the instrument and disconnect it from the mains network before installing or removing a communication module.

Installing communication module



– Remove the cover from the slot on the back of the instrument.
– Save the cover.
– Insert the communication module into the slot and fasten it with two screws.

Removing communication module

– Loosen both screws and pull out the communication module.
– If you do not wish to connect another communication module, replace the cover.

2.5 Connecting to the mains network

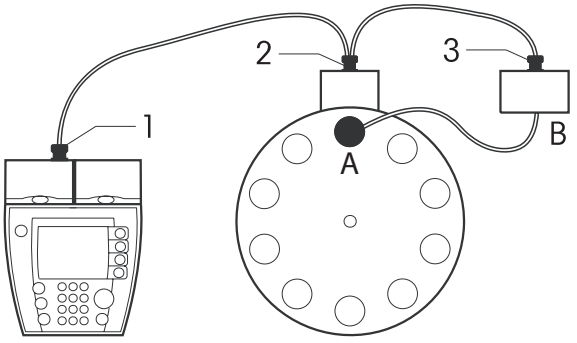
Safety precaution

– Operate SevenMulti™ with the supplied power supply only.
– Ensure that the power supply is designed for the mains voltage available where you are. If this is not the case, contact your METTLER TOLEDO representative.
– Insert the plug of the power supply into the mains connection socket (DC) on the back of SevenMulti™.
– Connect the power supply to an electrical outlet.

2.6 Connection of additional instruments to the TTL communication module

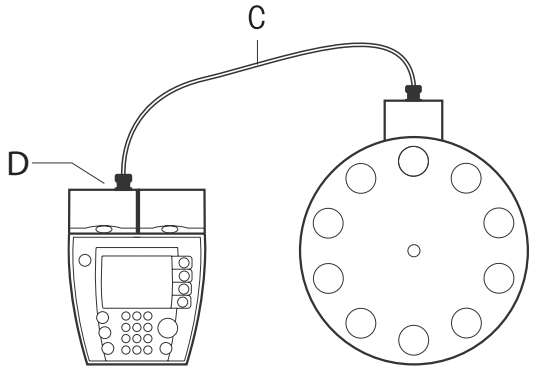
If SevenMulti™ is fitted with a TTL communication module, additional instruments such as the Rondolino sample changer can be attached.
SevenMulti™ has a control protocol for communication with the Rondolino sample changer.
If operation with the sample changer is activated in SevenMulti™, readings can be performed automatically without any additional settings.

Rondolino sample changer setup with propeller stirrer



A Propeller stirrer incl. cable (Order No. 51107019)
B Seven/Rondolino Stirrer Driver
incl y-shaped cable (Order No. 51302827)
1 male connector
2 female connector
3 female connector

Rondolino sample changer setup without propeller stirrer



C Standard TTL cable (Order No. 51190589)
D TTL communication module
(Order No. 51302825)

2.7 Connection of a computer via the USB communication module

SevenMulti™ can be equipped with a USB communication module for data transfer to a computer. The USB communication module includes a floppy disk with a driver which allows COM communication via the USB interface on the computer. This is offered for programs which do not support USB communication, e.g. MS Windows HyperTerminal. This allows, for example, IDs to be input with the barcode reader (RS232) and measured values to be transferred to the computer (USB) simultaneously. You can find more information about the settings for the USB-interface in chapter 4. System settings.
A detailed description for the installation of the software and the configuration of SevenMulti™ and the PC can be found on the Hompage of METTLER TOLEDO under "www.mt.com/LabX".

Note: Instead of installing the software from the enclosed floppy disk, you can download the actual driver from the internet (See above).

3. Operation of SevenMulti™

3.1 Operation with softkeys

SevenMulti™ has **4 softkeys**, whose functions are assigned differently depending on the application and the expansion unit used. The current assignment is shown on the screen to the left of the softkeys.

Working with 2 expansion units ("left" or "right" selected)

The softkeys are assigned as follows in the basic configuration of SevenMulti™ measurement display, with 2 expansion units:

Sys. Activate System menu

Menu Activate menu of expansion unit

Mode Select measurement method (e.g. pH or mV)

Dual Switch to dual display, i.e. the measured value display for an expansion unit is limited to the left or right half of the screen

Working with 2 expansion units (simultaneously)

The softkeys are assigned as follows in the basic configuration of SevenMulti™ measurement display, with 2 expansion units:

Sys. Activate System menu

Menu Activate Dual Channel menu

Left Select left expansion unit, i.e. the display for the left expansion unit is expanded to fill the screen, and settings can be made for the left expansion unit

Right Select right expansion unit, i.e. the display for the right expansion unit is expanded to fill the screen, and settings can be made for the right expansion unit

Softkeys in the expansion unit menus

The most important assignments of the softkeys in the menu are as follows:

↑ ↓ Select previous/next menu item

← For input: delete the last character

→ For input: switch to the next character

Enter Call up selected menu item

Select Select selected menu parameter

Save Accept selected parameter

Exit Back to previous (higher level) menu
To exit the menu, press the **Exit** key until the measurement display appears or press **Read**.

Only in data menu:

» Navigation within a data set

↓ Change to next data set

3.2 Operation using the alphanumeric keypad

The alphanumeric keypad allows you to access menu items directly. Position 10 is accessed using the number 0.

3.2.1 Alphanumeric input

Keys 2 through 9 may be assigned with several values, including the letters shown, depending on the input window which is active.

- If only numerical values are allowed in an input field (e.g. time, PIN code), the keys are assigned the numbers shown.
- If both letters and numbers are allowed in an input field, first the letters and then the number value can be entered by pressing the keys repeatedly.
- With the ← key, input can be deleted character-by-character from right to left.

Example: Input UTA7 = 2 x **8** 1 x **8** 1 x **2** 5 x **7**

Note: Only capital letters and numbers can be entered. It is not possible to enter special characters.

3.3 Entering IDs

SevenMulti™ allows you to identify your readings with sample, sensor and user IDs.
A maximum of 12 alphanumeric characters can be used for the identification of sample, method and sensor IDs, and a maximum of 8 alphanumeric characters for user IDs. Capital letters can be used, but special characters can not. All IDs can also be entered using a barcode reader (see Section 3.3.4 Enter ID using a barcode reader).

3.3.1 Enter Sample ID

– Press **ID** and confirm the menu item **1. Enter Sample ID** with **Enter**.
– Enter the sample ID with max. 12 characters using the alphanumeric keys.
– Press the **Save** softkey to save the sample ID and press **Exit** to exit the ID menu.

1. <Auto Sequential> On

If you enter a purely numeric sample ID (e.g. 123) or a sample ID that ends with numbers (e.g. water123), you can set it so that the sample ID is automatically incremented by 1 for each reading

2. <Auto Sequential> Off

The sample ID is not automatically incremented.

3.3.2 Enter Sensor ID/Sensor SN

– Press **ID**, select the menu item **2. Enter Sensor ID** and confirm with **Enter**.

– Enter the sensor ID using the alphanumeric keys using a maximum of 12 characters, or select a sensor ID from the list.

– Enter Sensor-ID, if required change to the entry box for Sensor-SN with ↓ and store the entries with **Save**.

– In the Ion mode a table of possible electrode types appears:

blank	CN^-	Na^+	S^{2-}
Ag^+	CO_2	NH_3	SCN^-
BF_4^-	Cu^{2+}	NH_4^+	Ion^+
Br^-	F^-	NO_2^-	Ion^{2+}
Ca^{2+}	H^+	NO_3^-	Ion^-
Cd^{2+}	I^-	NO_x	Ion^{2-}
Cl^-	K^+	Pb^{2+}	–

– To select the corresponding electrode type, move the cursor with the ↑ and ↓ keys column by column through the table.

Note: If you enter a new sensor, the previous calibration data is replaced by the theoretical values for this type of electrode. A new calibration must be performed because the calibration data is saved specifically for each sensor ID.

If you select a sensor ID from the list, the specific calibration data is loaded from memory.

3.3.3 Enter user ID

– Press **ID** and confirm the menu item **3. Enter User ID** with **Enter**.

– Enter the user ID with a maximum of 8 characters using the alphanumeric keys or select a user from the list.

– Press the **Save** softkey to save the user ID and press **Exit** to exit the ID menu.

3.3.4 Enter ID using a barcode reader

A barcode reader can be attached to the RS232 interface to automate the input of IDs (e.g. sample ID, sensor ID). Settings for the barcode reader are described in section 4. System settings.

If the barcode reader is activated in the measurement display, the sample ID is automatically entered. The Auto Sequential function must be deactivated beforehand. (Section 3.3.1 Enter Sample ID)

Note: Up to 12 characters can be read in. If a longer ID is read in with the barcode reader, only the first 12 places are accepted.

3.4 The Data menu

3.4.1 Menu structure of the Data menu

1. Store/Transfer Current Reading **Page 15**

2. Review/Transfer Current Calibration **Page 15**

3. Access Memory Functions **Page 15**

1. Review/Transfer Measurement Data
- **1.** Display All
- **2.** Search by Date
- **3.** Search by User
- **4.** Search by Sample ID
- **5.** Search by Sensor ID
- **6.** Search by Method Type

2. Review/Transfer Calibration Data
- **1.** pH
- **2.** Ion
- **3.** Conductivity
- **4.** ISFET

3. Review/Transfer Method Data

4. Review/Transfer Current Setting

5. Review/Transfer Incremental Meas. Data

6. Delete Measurement Data/Methods
- **1.** Delete Measurement Data
  - **1.** Delete All
  - **2.** Delete by Date
  - **3.** Delete by User Name
  - **4.** Delete by Sample ID
  - **5.** Delete by Sensor ID
  - **6.** Delete by Method Type
- **2.** Delete Calibration Data
  - **1.** pH
  - **2.** Conductivity
  - **3.** Ion
  - **4.** ISFET
- **3.** Delete Methods
- **4.** Delete Incremental Meas. Data
- **5.** Empty Memory

3.4.2 Operation of the Data-Menu

– Press **Data** to call up the Data menu.

In this menu, you can display overviews of:

- Measurement Data
- Calibration Data
- Method Data
- Instrument settings

You can transmit the displayed data to an attached computer or printer. Either the entire data record or individual data records are transmitted. In addition, in this menu you can also save data records and delete them again from memory.

1. Store/Transfer Current Reading

– If you want to manually save a reading, press **Data** when the reading has ended (measurement display freezes)

– In this menu open **1. Store/Transfer Current Reading** and confirm with **Save**.
The measurement data is stored.

– Note the message on the bottom line of the screen:
  - **Data are stored**: The measurement data is saved in memory.
  - **Memory is full**: The data memory is full. The measurement data was not stored.
    To clear the memory, see Data menu **3.5 Delete Measurement Data/Methods** .

– Pressing **Trans** transmits the displayed data record to an attached computer or printer.

– Switch back to measurement display with **Exit** or **Read**.

2. Review/Transfer Current Calibration

– Press **Data**, select **2. Review/Transfer Current Calibration** and confirm with **Enter**.

– Select in the Dual Channel menu the desired channel using **1. Left** or **2. Right** and press Enter to confirm. The current calibration data of the sensor is displayed.

– Pressing **Trans** transmits the displayed data record to an attached computer or printer.

3. Access Memory Functions

1. Review/Transfer Measurement Data

It is possible to create overviews of the stored measurement data:

- **All** measurement data
- Measurement data recorded as of a specific **date**
- Measurement data recorded by a specific **user**
- Measurement data recorded with a specific **sample ID**
- Measurement data recorded with a specific **sensor ID**
- Measurement data recorded with a specific **method**

The last saved data record of the selection appears on the screen.
The number and total amount of selected readings are displayed on the bottom line.

– Pressing the ↑ ↓ keys brings you to the data record of the previous/next reading.
– Press **Trans** and select if the currently shown data record or if all filtered data should be transferred to the connected PC or printer.

2. Review/Transfer Calibration Data

You can display the calibration data saved under a sensor ID for the following sensor types:

- pH sensor
- ion sensor
- conductivity sensor
- ISFET sensor

When a sensor ID is selected, the stored calibration data is displayed.

– Pressing the ↑ ↓ keys brings you to the previous/next calibration.
– Press **Trans** and select if the currently shown data record or if all filtered data should be transferred to the connected PC or printer.

3. Review/Transfer Method Data

You can display the stored method data for the different measurement modes:

- pH
- conductvity
- ion
- mV
- Rel. mV
- TDS
- Salinity
- Resistivity
- ISFET pH
- ISFET mV
- ISFET rel. mV

After selecting a measuring mode, you can select **1. Enter Method ID** or **2. Select Method ID from List**, to call up the corresponding stored methods.
After selection of the method the corresponding method parameters are shown.
– Pressing **Trans** transmits the displayed data record to an attached computer or printer and ends the procedure.

4. Review/Transfer Current Setting

The current instrument settings are displayed.

– Pressing the **Trans** key transmits the displayed data record to an attached computer or printer.

5. Review/Transfer Incremental Meas. Data

You can display the incremental measurement data

– Press **Trans** and select if the currently shown data record or if all filtered data should be transferred to the connected PC or printer.

6. Delete Measurement Data/Methods

Note: This menu is protected by a PIN code. Upon delivery, the PIN code is set to **000000**. Please change the PIN code to prevent unauthorised access.

With this menu, you can delete stored measurement data, calibration data and methods based on specific criteria:

1. Delete Measurement Data
deletes measurement data from memory based on the following criteria:

- **All** measurement data
- Measurement data recorded on a specific **date**
- Measurement data recorded by a specific **user**
- Measurement data recorded with a specific **sample ID**
- Measurement data recorded with a specific **sensor ID**
- Measurement data recorded with a specific **method**

2. Delete Calibration Data
deletes all calibration data for the selected sensor ID from memory.

– Select measurement parameter (pH, conductivity, ion, ISFET) with **Select**.

– Select sensor ID with ↑ or ↓ and press **Del.** to delete the data record.

– Confirm or cancel the action when the message **This will delete all your selected data** appears with **Yes** or **Exit** accordingly.

Note: Only sensor IDs that are currently not in use are available in the list for deletion. An active sensor ID cannot be deleted.

3. Delete Methods
removes method data for specific measurement.

– Select measurement parameter (pH, conductivity, ion, ISFET, mV, Rel.mV, TDS, Salinity, Resistivity) with **Select**.

– Enter the method ID or select the method to be deleted from the list using the arrow keys and press **Delete** to delete.

– Confirm or cancel the action when the message **This will delete all your selected data** appears with **Yes** or **Exit** accordingly.

Note: Only methods not currently in use are available in the list for deletion. An active method cannot be deleted.

4. Delete Incremental Meas. Data
deletes all incremental measurement data from memory.

5. Empty Memory
removes all measurement data, all calibration data and methods from memory.

3.5 The i menu

3.5.1 Help information

SevenMulti™ features extensive context-sensitive help information.

– Press (i).
  Help information for the current operation step appears on the display for the selected topics.

– Press ?.
  A general information menu of the system is available.

3.5.2 Instrument Self-test

This menu item starts the self-test routine. You are requested to press each key one by one in any order. The self-test result is displayed after a few seconds.
If errors are reported: Contact METTLER TOLEDO Service.

Note: You have to finish pressing all keys within two minutes, otherwise "Self test failed!" appears, and you will have to repeat the procedure.

3.5.3 Remote Control On/Off

You can control SevenMulti™ via commands from PC software. The precondition is that you select **LabX** in the system settings. You can block the control on the meter itself with **Remote Control On**. Only the start and end of a measurement and a calibration is possible from the meter. All other changes to settings have to be carried out via commands from the PC software.

3.5.4 Routine/Expert Mode

You can operate the SevenMulti in the Routine mode or in the Expert mode. In the expert mode you have complete access to all the instrument settings and functions whereas in the routine mode user rights are restricted; e.g. system settings are not possible. If routine mode is activated an icon **[R]** is displayed.

In the Routine mode you can perform the following operations:

- Measure
- Calibrate
- Review, store and transfer data
- Choose the MTC temperature
- Review and load methods
- Enter sample, sensor and user IDs
- Start Rondolino readings and calibration
- Perform the electrode test

Note: Switching between the Routine and Expert modes is protected by a PIN code. The PIN code corresponds to that of the system settings. Upon delivery, the PIN code is set to **000000**.

4. The system menu

4.1 Menu structure of the system menu

1. Select Language Page 20

- **1.** English
- **2.** Deutsch
- **3.** Français
- **4.** Español
- **5.** Italiano

2. Set Time and Date Page 20

- **1.** Set Time
  - **1.** 24 Hour Format
  - **2.** 12 Hour Format
- **2.** Set Date
  - **1.**Set Date: mm-dd-yy
  - **2.**Set Date: dd-mm-yy

3. Screen Setting Page 20

- **1.** Screen Contrast
- **2.** Screen Saver
  - **1.** Off
  - **2.** On

4. Interface Settings Page 21

- **1.** Output/Input
  - **1.** Output
    - **1.** Printer
    - **2.** BalanceLink/Hperterminal
  - **2.** Input
- **2.** LabX

5. Printout Format Page 22

- **1.** GLP
- **2.** Standard
- **3.** Short

6. Instrument/Expansion Unit ID Page 23

- **1.** Set Instrument ID
- **2.** Set Expansion Unit ID

7. Login/System settings PIN Codes Page 23

- **1.** Set Instrument Login PIN code
- **2.** Set system settings PIN code
- **3.** Set PIN code for deletion

8. Qualified Measurement only Page 24

- **1.** On
- **2.** Off

4.2 Operation of the system menu

– To call up the system menu, press **Sys.** in the measurement display.

Note: This menu is protected by a lab manager's PIN code. Upon delivery, the PIN code is set to **000000**. Please change the lab manager's PIN code to prevent unauthorised access.

1. Select Language

The following languages are available for the system: German, English, French, Spanish and Italian.
– Select the desired language and confirm with **Select**.

2. Set Time and Date

1. Set Time

You can select between two display formats:

24 Hour Format: E.g.: 18:56

12 Hour Format: E.g.: 06:56 PM

For 12 Hour Format, select the time of day with **AM/PM**: AM = morning; PM = after 12 noon

2. Set Date

You can select between two display formats:

mm-dd-yy (month - day - year): E.g.: 09-27-03

dd-mm-yy (day - month - year): E.g.: 27-09-03

3. Screen Setting

1. Screen Contrast

You can set the contrast of the screen to one of 32 levels with the ↑ ↓ keys.

2. Screen Saver

1. Off

2. On

In this menu, you set the amount of time which passes before the screen saver is activated:
5 – 99 minutes

If SevenMulti™ is not operated during this time, the screen saver is activated. Press any key and the display is activated again independent of the function of the key.

Note: The display has a limited lifetime and therefore we recommend activating the screen saver or switching of the meter when not in operation.

4. Interface Settings

This menu allows you to set the interface parameters depending on the requirements of the connected instruments. You can set different parameters for the input and output of the instrument if for example you want to connect a bar-code reader and a printer with different baud rates. The specific parameters for the printer are set under 1.1. Output and for the barcode reader under **1.2. Input**.

Note: If you want to operate the SevenMulti™ using a computer software program, you must select **LabX** and set the specific parameters. With this setting there is no automatic printout through the interface anymore. The data must be requested through PC software. If you are using **LabX direct pH** for data transfer you also need to select **LabX**.

1. Output / Input

1. Output

1. Printer:

- Baud rate 1200, 2400, 4800, 9600
- Data bit 7, 8
- Stop bit 1, 2
- Parity no, odd, even
- Handshake no, xon/xoff

2. BalanceLink/Hyperterminal:

- Baud rate 1200, 2400, 4800, 9600
- Data bit 7, 8
- Stop bit 1, 2
- Parity no, odd, even
- Handshake no, xon/xoff

2. Input

- Baud rate 1200, 2400, 4800, 9600
- Data bit 7, 8
- Stop bit 1, 2
- Parity no, odd, even
- Handshake no, xon/xoff

2. LabX

- Baud rate 1200, 2400, 4800, 9600
- Data bit 7, 8
- Stop bit 1, 2
- Parity no, odd, even
- Handshake no, xon/xoff

– Use ↓ ↑ to select the input field and select the desired setting using **Change**.

– Press **Save** to save your settings.

5. Printout format

This menu item allows you to define the desired format for your **printout**.
If you select **GLP Format**, you can enter a header for your printout.

1. GLP

Example for **GLP Format** (Measurement in pH mode)

Channel L
Format: GLP
Date: 25-JUL-2005
Time: 09:31
Sensor ID: INLAB413
Sensor SN: 5051234
Last Cal.: 24-JUL-2005
Cal. time 11:25
Instrument ID: ANA1
Instrument SN: 123456789
Exp.unit ID: PH1
Exp.unit SN: 230006p
User: MEIER
Method: LAP1
Endpoint: Automatic
ATC/MTC MTC
Time int.: 120s
Automation: Pos.:3
Sample ID: WATER
Result : 6.997pH
mV: 0.2mV
Temperature: 23.0°C
Alarm: Max pH
Min Temp
Signature: _____

2. Standard

Example for **Standard Format** (Measurement in pH mode)

Channel L
Date: 25-JUL-2005
Time: 10:56
Endpoint: Automatic
ATC/MTC MTC
Sample ID: WATER
Result: 6.997pH
mV: 0.2mV
Temperature: 25.0°C

3. Short

Example for **Short Format** (Measurement in pH mode)

Channel L
6.997 pH 25.0 °C MTC

6. Instrument/Expansion unit ID

1. Set Instrument ID

The current instrument ID is displayed in the input field of the input window.
– Enter an alphanumeric instrument ID (max. 6 places).
The entered instrument ID remains intact when the instrument is switched off.
Note: When SevenMulti™ is delivered, no instrument ID is set.

2. Set Expansion unit ID

In this menu, you can allocate an expansion unit ID to the expansion units in the left and right slots.
– Select right or left slot with **Select**.
The input window for the ID of the expansion unit appears.
The current ID is displayed via the input field.
– Enter an alphanumeric ID (max. 6 places).
The menu for selection of the expansion unit in the left or right slot reappears.
– Repeat steps for the second expansion unit or end procedure with **Exit**.

7. Login/System settings PIN codes

1. Set Instrument Login PIN code

Setting a login password can protect SevenMulti™ from unauthorised use. When the instrument is switched on, the user must enter the login password in order to be able to use the instrument. When SevenMulti™ is delivered, no login password is set.

– Activate/deactivate login password protection with **Password protection On / Off**.
– Enter a numeric login password (max. 6 places).
The input window for verification of the login password appears.
– Reenter password.

Note: If entry was not successful, the password must be reentered and verification must be performed again.

2. Set system settings PIN code

– Enter a numeric PIN code (max. 6 places).
The input window for verification of the PIN code appears.
– Reenter PIN code.

Note: If entry was not successful, the PIN code must be reentered and verification must be performed again.
The PIN code for the system settings is also valid for switching between the Expert and Routine modes
Upon delivery, the PIN code is set to **000000**.

3. Set PIN code for deletion

– Enter a numeric PIN code (max. 6 places).
The input window for verification of the PIN code appears.
– Reenter PIN code.

Note: If entry was not successful, the PIN code must be reentered and verification must be performed again.
Upon delivery, the PIN code is set to **000000**.

8. Qualified Measurement only

Activating this menu point blocks SevenMulti™ automatically for measurements if a predefined time interval for calibration is exceeded. Only calibration can then be done with the current sensor ID until the next successful calibration has been carried out.

1. On

If during calibration the calibration reminder goes off, the meter will be blocked for measurements until the next successful calibration has been carried out.

2. Off

Measurement is still possible.

5. The Dual menu

5.1 Menu structure of the Dual Channel menu

1. Select Endpoint Formats **Page 26**

- **1.** Auto
- **2.** Manual
- **3.** Timed

2. Set MTC Temperature **Page 26**

3. Timed Interval Readings **Page 26**

- **1.** On
  - **1.** Log to Memory
  - **2.** Log to Interface
  - **3.** Log to Memory and Interface
- **2.** Off

4. Select Data Transfer Mode **Page 27**

- **1.** Automatic Data Transfer
  - **1.** Log to Memory
  - **2.** Log to Interface
  - **3.** Log to Memory and Interface
- **2.** Manual Data Transfer to Memory

5. Activate Rondolino Sample Changer **Page 27**

- **1.** Measurement

6. Dual Channel Method in Memory **Page 28**

- **1.** Load a Stored Method from Memory
- **2.** Save Current Settings as a Method

5.2 Operation of the Dual Channel menu

If you have installed two expansion units, you can use the Dual Channel menu to set certain parameters that are the same for both expansion units.
Specific settings for the two expansion units must however be set individually for each unit using the right or left channel.

1. Select Endpoint Formats

1. Auto

With the automatic endpoint, special algorithms determine the end of an individual measurement, depending on the behaviour of the sensor used. This ensures an easy, quick and precise measurement.

– Start measurement with **Read**.
The measurement ends automatically when the measured value is stable.

2. Manual

– Start measurement with **Read**.

– End measurement by pressing **Read** again.

3. Timed

With the timed endpoint, measurement is started with **Read**. The measurement is ended automatically when the set time period expires.

You set this time period (3 s to 3600 s) in the following input window.

2. Set MTC Temperature (manual temperature compensation)

If you are working without a temperature sensor during the measurement, enter the temperature of the sample in this menu (– 30 °C … 130 °C).

3. Timed Interval Readings

In this menu, you activate and deactivate series measurements and set the time interval between two successive measurements.

1. On

The input window for the time interval (3 s to 2400 s) appears.
When the time interval is entered, a menu appears for selection of the mode of measured data recording:

1. Log to Memory

The measured data is saved in the SevenMulti™ memory.

2. Log to Interface

The measured data is transferred to an attached computer or printer via the interface.

3. Log to Memory and Interface

The measurement data is saved in SevenMulti™ and transferred to an attached computer or printer via the interface.

2. Off – no series measurement.

4. Select Data Transfer Mode

1. Automatic Data Transfer

1. Log to Memory

The measured data is saved in the SevenMulti™ memory.

2. Log to Interface

The measured data is transferred to an attached computer or printer via the interface.

3. Log to Memory and Interface

The measurement data is saved in SevenMulti™ and transferred to an attached computer or printer via the interface.

2. Manual Data Transfer to Memory

Automatic measurement-data transfer is deactivated. If you would like to store the measured values after a measurement, press **Data** (see Section 3.4.2 Operation of the **Data**-Menu).

5. Activate Rondolino Sample Changer

1. Measurement

If you want to start the measurement with the sample changer using the currently displayed settings:

– Press **Start**. The reading with the sample changer starts.

If you want to change the sample ID:

– Press **Edit**. The input window to enter the sample IDs of the first 5 Rondolino positions appears.

– Enter the sample ID using the alphanumeric keypad or the barcode reader.

– Using ↓ move to the input window of the next Rondolino position. Up to 9 Rondolino positions can be entered. The number of sample IDs entered determines the number of samples to be measured.

– Press **Save** to confirm the last entry. A table showing the data entered appears.

– Press **Start**. The measurement with the sample changer starts.

Notes

- A METTLER TOLEDO titration stirrer can be connected using the Seven/Rondolino Stirrer Driver accessories. This allows fully-automatic measurement with a high degree of repeatability.
- If you have selected log to interface, the data is transferred to the printer after each individual measurement. If you have selected log to memory, the data will be saved as in a normal measurement.

6. Dual Channel Method in Memory

Up to 5 dual channel methods can be stored.

Before saving a dual channel method you first need to save a single channel method for each channel, otherwise an error message appears **Please save single channel method first**. A dual channel method is the combination of two single channel methods.

1. Load a Stored Dual Channel Method from Memory

A list of the names of stored measurement methods appears on the screen.

– Select the desired method with the arrow keys.

– Press **Select** to show the two single channel methods of the selected dual channel method.

– Press **Load** to load the parameters for the subsequent measurements.

2. Save Current Settings as a Method

The entry box for entering the Method ID appears.

The current methods and measurement modes of both channels are displayed.

– Press **Save** to store the methods as a dual channel method.

5.3 Measuring with two expansion units

If two expansion units are installed, the screen is divided into two areas while measuring:
Left for the expansion unit installed on the left , **Right** for the right expansion unit (dual display).
The measurements are performed with both expansion units simultaneously.

Note: To restart a reading, the endpoints of the readings must have been reached in both channels.

Settings for the expansion units

Settings that are the same for both expansion units can be entered using the Dual **Menu** as described in the current chapter.
Settings that are specific to the particular expansion unit must be entered using the individual channels.

– Select the right or left expansion unit with **Left** or **Right**.

– Make menu and/or mode settings as described for the expansion units.

6. The pH/Ion and ISFET expansion units

6.1 The pH mode

6.1.1 Menu structure of the pH mode

1. Calibration Setting Page 30

- **1.** Set Calibration Buffer
  - **1.** Select a Standard Buffer Group
  - **2.** Set a Customized Buffer Group
- **2.** Select Calibration Mode
  - **1.** Segment method
  - **2.** Linear method
- **3.** Set Calibration Reminder
  - **1.** Off
  - **2.** Remind by Interval Time

2. Electrode test Page 32

3. Select Resolution and Stability Criterion Page 32

- **1.** Select Display Resolution
  - **1.** X.X
  - **2.** X.XX
  - **3.** X.XXX
- **2.** Select Stability Criterion
  - **1.** Fast
  - **2.** Normal
  - **3.** Strict

4. Select Endpoint Formats Page 33

- **1.** Auto
- **2.** Manual
- **3.** Timed

5. Set MTC Temperature Page 33

6. Set Alarm Limits Page 34

- **1.** pH Max. Limit
- **2.** pH Min. Limit
- **3.** Temperature Max. Limit
- **4.** Temperature Min. Limit
- **5.** Calibration Offset Max. Limit
- **6.** Calibration Offset Min. Limit
- **7.** Calibration Slope Max. Limit
- **8.** Calibration Slope Min. Limit

7. Timed Interval Readings Page 34

- **1.** On
  - **1.** Log to Memory
  - **2.** Log to Interface
  - **3.** Log to Memory and Interface
- **2.** Off

8. Select Data Transfer Mode Page 34

- **1.** Automatic Data Transfer
  - **1.** Log to Memory
  - **2.** Log to Interface
  - **3.** Log to Memory and Interface
- **2.** Manual Data Transfer to Memory

9. Activate Rondolino Sample Changer Page 35

- **1.** Measurement
- **2.** Calibration

10. pH Methods in Memory Page 36

- **1.** Load a Stored pH Method from Memory
- **2.** Save Current Settings as a Method

6.1.2 Operation of the pH menu

– If two expansion units are attached, first ensure that the desired expansion unit is selected.
– Press **Mode** and press **pH** in the menu that appears to select the pH mode.
– Call up the pH menu with **Menu**.

1. Calibration Setting

1. Set Calibration Buffer

1. Select a Standard Buffer Group

– Select a predefined standard pH buffer group.

The following buffer groups are predefined.

Nr.	Buffer 1	Buffer 2	Buffer 3	Buffer 4	Buffer 5	Temp.	Designation
1.	1.68	4.00	7.00	10.01	–	25 °C	METTLER TOLEDO US
2.	2.00	4.01	7.00	9.21	11.00	25 °C	METTLER TOLEDO Europe
3.	2.00	4.00	7.00	9.00	12.00	20 °C	Merck standard buffers
4.	1.680	4.008	6.865	9.184	12.454	25 °C	DIN (19266) / NIST
5.	1.09	4.65	6.79	9.23	12.75	25 °C	DIN (19267)
6.	1.680	4.003	6.864	9.182	12.460	25 °C	JJG 119
7.	2.00	4.01	7.00	10.00	–	25 °C	Technical buffers
8.	1.679	4.008	6.865	9.180	–	25 °C	JIS Z 8802

1. Auto buffer recognition On

The SevenMulti™ features automatic calibration-buffer recognition. This allows you to calibrate in any order you like within a buffer group.

Note: If the measured mV value for the first calibration point deviates by more than 60 mV (approx. ± 1 pH) from the theoretical value of the calibration buffer-point, the **Offset out of range** warning appears.

2. Auto buffer recognition Off

Switch off the automatic buffer recognition if you want to specify the order of the pH buffers yourself or if the offset value deviates too much from the theoretical value (e.g. in readings using electrodes that contain a non-aqueous electrolyte.

– A table for selection of the pH buffers appears.
– Press **Change** to define the order of the pH buffers. Navigate to the next input field using ↓.
– Press **Save** to accept the list.

2. Set a Customized Buffer Group

This menu allows you to define your own set of pH buffers with up to 5 different temperatures for each buffer for calibrating SevenMulti™.

– Please note that the temperature difference between buffers must be at least 5 °C and the difference between the pH values must be at least 1.

Nr.	Temp.	Buffer 1	Buffer 2	Buffer 3	Buffer 4	Buffer 5
1.						
2.						
3.						
4.						
5.						

– Press **Change** to access the table.

– You can navigate within the table using the ↑ and ↓ keys and delete the value using ←.

– Press **End** to finish editing the table and **Save** to store the values.

1. Auto buffer recognition On

(see **1. Select a standard buffer group**)

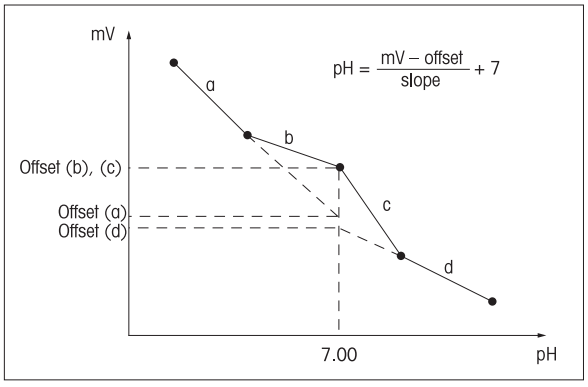
2. Auto buffer recognition Off

(see **1. Select a standard buffer group**)

2. Select Calibration Mode

1. Segmented Method

The segmented method is the most modern method for precise pH readings. The calibration curve is made up of line segments joining the individual calibration points rather than a linear regression through them. This takes into account any non-linear behavior of the electrode over a large pH range. In the diagram, the segments a, b, c and d all have different slopes. The offset, defined as the potential at pH 7 is also different for segments a, b and d while that for segments b and c is the same. This is because they both share the pH 7 buffer, which is in fact the offset.



The segmented method is preferred for high-precision readings.

2. Linear Method

With this method, the calibration curve is determined via a linear regression line.

The linear method is preferred when samples with greatly varying pH values are to be compared.

3. Set Calibration Reminder

1. Off – no calibration reminder

2. Remind by Interval Time

If the calibration reminder is active, you are reminded to perform a new calibration after a specified amount of time has passed. The reminder comes in the form of a message on the bottom line of the measurement display.

Activating this item leads to an input window, into which you enter the time interval (1 to 1000 h).

2. Electrode test

This menu allows you to check the drift, the slope, the offset and the response time of your pH electrode without performing an adjustment.

– Select two buffers from the current buffer group.

– Place the electrode in the first buffer solution and press Meas. When the measured value is stable, the first reading is automatically ended and the message Place electrode in buffer 2 appears on the display.

– Place the electrode in the second buffer solution and press Meas. The reading is automatically ended and the sensor ID, the results for the drift (mV/min), the slope (%), the offset (mV) and the response time (s) are displayed with the message OK/critical.

Measurement Criteria:

– The measurement will endpoint once the measurement signal changes less than 0.5 mV in 10 seconds.

– For calculation of the response time the time (sec.) is taken from the start of the second measurement until 98 % of the difference between the reading for the two buffers is reached. (i.e. mV1 + 0.98 · (mV2 – mV1))

– For the drift determination a measurment is taken after 60 seconds from the start of the measurement in the second buffer and again after a further 30 seconds. The drift is then the difference between the 2 readings in mV/30s.

Limits:

– Drift is OK if less than 3 mV in 30 seconds.

– Slope is OK from 90 to 105 % of the theoretical slope.

– Offset is OK if in the range of ± 30 mV.

– Response time is OK if less than 60 seconds.

The limits within the meter apply to a test using pH 4 and 7 buffers or similar.

3. Select Resolution and Stability Criterion

1. Select Display Resolution

In this menu, you select the resolution to which the measurement display is to be shown:

1. X.X one decimal place

2. X.XX two decimal places

3. X.XXX three decimal places

2. Select Stability Criterion

In this menu you can define the stability criterion of your measurement

Stability criterion for fast
The measured signal may not change by more than 0.6 mV in 4 seconds.

Stability criterion for normal
The measured signal may not change by more than 0.1 mV in 6 seconds.

Stability criterion for strict
The measured signal may not change by more than 0.03 mV in 8 seconds or by more than 0.1 mV in 30 seconds

4. Select Endpoint Formats

1. Auto

With the automatic endpoint the selected stability criterion determines the end of an individual reading depending on the behavior of the sensor used. This ensures an easy, quick and precise measurement.

– Start measurement with **Read**.
  The measurement ends automatically when the measured value is stable.

2. Manual

– Start measurement with **Read**.

– End the measurement by pressing **Read** again.

3. Timed

With the timed endpoint, measurement is started with **Read**. The measurement is ended automatically when the set time period expires.

You set this time period (3 s to 3600 s) in the following input window.

Information on the display

The following symbols appear in the display, depending on the endpoint setting :

Preselected format	Start of measurement	Signal stability	Endpointed measurement [1]
Auto endpoint	A	A	A
	A	**Read** ⟹	M
Manual endpoint	M	**Read** ⇨	M
	M	**Read** ⟹	M
Timed endpoint	T	⇨	T
	T	**Read** ⟹	M

[1] The actual endpoint format (last column) not the preselected is stored with the data.

5. Set MTC Temperature (manual temperature compensation)

If you are working without a temperature sensor during the pH measurement, enter the temperature of the sample in this menu (–30 °C … 130 °C). SevenMulti™ calculates the temperature-adjusted electrode slope with this temperature and shows the temperature-compensated pH value in the measurement display.

6. Set Alarm Limits

In this menu, you can define the upper and lower limits for measurement or calibration data. If a limit is exceeded or undershot, a warning is output to the screen. This message also appears on the GLP printout.

Before entering a limit, you can activate or deactivate the alarm for this limit.

Parameter	Minimum	Maximum	Unit
pH value	–2.000	20.000	pH
Temperature	–30.0	130.0	°C
Calibration offset	–60.0	60.0	mV
Calibration slope	85.0	110.0	%

7. Timed Interval Readings

In this menu, you activate and deactivate series measurements and set the time interval between two successive measurements.

1. On

The input window for the time interval (3 s to 2400 s) appears.
When the time interval is entered, a menu appears for selection of the mode of measured data recording:

1. Log to Memory

The measured data is saved in the SevenMulti™ memory.

2. Log to Interface

The measured data is transferred to an attached computer or printer via the interface.

3. Log to Memory and Interface

The measurement data is saved in SevenMulti™ and transferred to an attached computer or printer via the interface.

2. Off – no series measurement

8. Select Data Transfer Mode

1. Automatic Data Transfer

1. Log to Memory

The measured data is saved in the SevenMulti™ memory.

2. Log to Interface

The measured data is transferred to an attached computer or printer via the interface.

3. Log to Memory and Interface

The measurement data is saved in SevenMulti™ and transferred to an attached computer or printer via the interface.

2. Manual Data Transfer to Memory

Automatic measurement-data transfer is deactivated. If you would like to store the measured values after a measurement, press **Data** (see Section 3.4.2 Operation of the **Data**-Menu).

9. Activate Rondolino Sample Changer

1. Measurement

If you want to start the reading with the sample changer using the currently displayed settings:

– Press **Start**. The reading with the sample changer starts.

If you want to change the sample IDs:

– Press **Edit**. The input window to enter the sample IDs of the first 5 Rondolino positions appears.

– Enter the sample ID using the alphanumeric keypad or the barcode reader.

– Change to the input field of the next Rondolino position using ↓. Up to 9 Rondolino positions can be entered. The number of sample IDs entered determines the number of samples to be measured.

– Press **Save** to confirm the last entry. A table with the data entered appears.

Press **Start**. The reading with the sample changer starts.

2. Calibration

– The current buffer group is displayed.

– To change the buffer group, exit the Rondolino menu and select a new buffer group in the Calibration set ting menu.

– Enter the number of the buffers and press **Save** to confirm.

– Press **Start**. After the last reading, a table appears with the results of the calibration.

– To assess the calibration, display the calibration curve (mV vs. pH) graphically using Graph.

- The calibration points are shown as crosses.
- In the segment method, the calibration points are joined by straight lines.
- In the linear method, the calibration curve is calculated as a linear regression.

– Press **Save** to use the calibration for further measurements.

– Press **Cancel** to discard the calibration.

Notes

- A METTLER TOLEDO titration stirrer can be connected using the Seven/Rondolino Stirrer Driver accessories. This allows fully-automatic measurement with a high rate of repeatability.
- For measurements: If you have selected log to interface, the data is transferred after each individual reading. If you have selected log to memory, the data is saved as in a normal reading.

10. pH Methods in Memory

A total of 40 methods for all applications can be stored.

1. Load a Stored Method from Memory

A list of the names of stored measurement methods appears on the screen.

- Select the desired method with the arrow keys.
- Display the parameters of the selected method with **Select**.
- Press **Load** to load the parameters for the subsequent measurements.

2. Save Current Settings as a Method

The current settings for the reading are displayed.

- Press the **Save** key.
  The input window for entry of the name of the measurement method appears.
- When the name has been entered, press **Save** again to store the measurement method.
- A method ID cannot be used twice. It must first be deleted before it can be used again. Otherwise the **Method ID already exists** error message appears.

6.1.3 Measuring a pH value

Note: To ensure precise pH-value measurements, perform a calibration before each series of measurements (see Section 6.1.2 Operation of the pH menu).

- Attach a suitable pH electrode to the pH expansion unit.
- If the pH electrode does not have a temperature sensor, enter the sample temperature manually (see pH menu **5. Set MTC Temperature**).
- Place the pH electrode in the sample and press **Read**.
  The pH value of the sample is shown on the display.
- In the automatic or timed endpoint format, the endpoint becomes stable either automatically or after a predefined time and the display freezes.
- End the measurement manually by pressing **Read** again.

6.1.4 Calibrating a pH electrode

Preparing for calibration

- Have calibration buffers on hand.
  Max. 5 different calibration buffers are possible.
- Enter the parameters of the calibration buffers in the pH menu under **1.1 Set Calibration Buffer**.
- In the pH menu under **1.2. Select Calibration Mode**, select the calibration mode.

Calibrating

– Place the electrode in the first calibration buffer and press **Cal** to start calibrating.
CAL 1 on the screen indicates that the first calibration point is being measured.
If a standard other than the selected one is to be used, it can still be changed using the ⌂ key.
Depending on the endpoint format, the value is displayed when the measured value is stable.

– Rinse off electrode.

– Place the electrode in the second calibration buffer and press **Cal** to start calibrating again.
CAL 2 on the screen indicates that the second calibration point is being measured.
Depending on the endpoint format, the value is displayed when the measured value is stable.

– Repeat the procedure for all calibration buffers.

– End calibration with **End** after reading of the last calibration buffer.
A table with the calibration results appears in the display.

Checking calibration

– To gauge the calibration, display the calibration curve (mV vs. pH) graphically with **Graph.**.
  • The calibration points are displayed as crosses.
  • With the segment method, the calibration points are connected by straight lines.
  • With the linear method, the calibration curve is calculated as a best fit straight line.

– Press **Save** to use the calibration and make an adjustment for subsequent measurements.

– Press **Cancel** to discard the calibration.

Notes for Standard and Customized buffer groups

- The pH electrode can only be calibrated in the temperature range in which the pH values of the selected buffer group are defined, e.g. between 5 °C and 50 °C for standard buffer groupsor for the range you have defined for the user-defined buffer groups. Otherwise the warning **Buffer temp. out of range** appears.
- If the measured mV value for calibration points 2 through n deviates by more than 60 mV (approx. ± 1 pH) from the theoretical value of the calibration buffer during an n-point calibration, the **Slope out of range** warning appears.
- If for an n-point calibration the same calibration buffer is used twice or two calibration buffers whose mV values differ less than 60 mV are used, the **Wrong Buffer** warning appears.
- In the calibration, the **measured temp. differs from setting** warning appears if the temperature deviation from the temperature range entered is more than 0.5 °C for standard buffer groups and more than 1 °C for user-defined buffer groups.
- If you perform a 1-point calibration using a sensor ID with which you have already performed a multi-point calibration, only the offset value is changed. The slope of the previous multi-point calibration is retained.

6.2 The mV/rel. mV mode

6.2.1 Menu structure of the mV/rel. mV mode

1. Select Resolution and Stability Criterion Page 39

- **1.** Select Display Resolution
  - **1.** X
  - **2.** X.X
- **2.** Select Stability Criterion
  - **1.** Fast
  - **2.** Normal
  - **3.** Strict

2. Select Endpoint Formats Page 39

- **1.** Auto
- **2.** Manual
- **3.** Timed

3. Set MTC Temperature Page 40

4. Set mV/rel. mV Alarm Limits Page 40

- **1.** mV Max. Limit
- **2.** mV Min. Limit
- **3.** Temperature Max. Limit
- **4.** Temperature Min. Limit

5. Timed Interval Readings Page 40

- **1.** On
  - **1.** Log to Memory
  - **2.** Log to Interface
  - **3.** Log to Memory and Interface
- **2.** Off

6. Select Data Transfer Mode Page 41

- **1.** Automatic Data Transfer
  - **1.** Log to Memory
  - **2.** Log to Interface
  - **3.** Log to Memory and Interface
- **2.** Manual Data Transfer to Memory

7. Activate Rondolino Sample Changer Page 41

- **1.** Measurement

8. mV/rel. mV Methods in Memory Page 42

- **1.** Load a Stored Method from Memory
- **2.** Save Current Settings as a Method

9. rel. mV Offset Setting[1)] Page 42

- **1.** Enter an Offset Value
- **2.** Test a Reference Sample

1.) You can only set this in the rel. mV menu.

6.2.2 Operation of the mV/rel. mV menu

– If two expansion units are attached, first ensure that the desired expansion unit is selected.
– Press **Mode** and press **mV/rel. mV** in the menu that appears to select the mV/rel. mV mode.
– Call up the mV/rel. mV menu with **Menu**.

1. Select Resolution and Stability Criterion

1. Select Display Resolution

In this menu, you select the resolution to which the measurement display is to be shown:

1. X no decimal place

2. X.X one decimal place

2. Select Stability Criterion

In this menu you can define the stability criterion of your measurement

Stability criterion for fast
The measured signal may not change by more than 0.6 mV in 4 seconds.

Stability criterion for normal
The measured signal may not change by more than 0.1 mV in 6 seconds.

Stability criterion for strict
The measured signal may not change by more than 0.03 mV in 8 seconds or by more than 0.1 mV in 30 seconds

2. Select Endpoint Formats

1. Auto

With the automatic endpoint the selected stability criterion determines the end of an individual reading depending on the behavior of the sensor used. This ensures an easy, quick and precise measurement.
– Start measurement with **Read**.
The measurement ends automatically when the measured value is stable.

2. Manual

– Start measurement with **Read**.
– End the measurement by pressing **Read** again.

3. Timed

With the timed endpoint, measurement is started with **Read**. The measurement is ended automatically when the set time period expires.

You set this time period (3 s to 3600 s) in the following input window.

Information on the display

The following symbols appear in the display, depending on the endpoint setting:

Preselected format	Start of measurement	Signal stability	Endpointed measurement [1]
Auto endpoint	A	A	A
	A	**Read** ⟹	M
Manual endpoint	M	**Read** ⇨	M
	M	**Read** ⟹	M
Timed endpoint	T	⇨	T
	T	**Read** ⟹	M

[1] The actual endpoint format (last column) not the preselected is stored with the data.

3. Set MTC Temperature (manual temperature compensation)

If you are working without a temperature sensor during the mV/rel. mV measurement, enter the temperature of the sample in this menu (–30 °C … 130 °C).

5. Set Alarm Limits

In this menu, you can define the upper and lower limits for measurement or calibration data. If a limit is exceeded or undershot, a warning is output to the screen. This message also appears on the GLP printout.

Before entering a limit, you can activate or deactivate the alarm for this limit.

Parameter	Minimum	Maximum	Unit
mV value	–1.999	1.999	mV
Temperature	–30.0	130.0	°C

5. Timed Interval Readings

In this menu, you activate and deactivate series measurements and set the time interval between two successive measurements.

1. On

The input window for the time interval (3 s to 2400 s) appears.
When the time interval is entered, a menu appears for selection of the mode of measured data recording:

1. Log to Memory

The measured data is saved in the SevenMulti™ memory.

2. Log to Interface

The measured data is transferred to an attached computer or printer via the interface.

3. Log to Memory and Interface

The measurement data is saved in SevenMulti™ and transferred to an attached computer or printer via the interface.

2. Off – no series measurement

6. Select Data Transfer Mode

1. Automatic Data Transfer

1. Log to Memory

The measured data is saved in the SevenMulti™ memory.

2. Log to Interface

The measured data is transferred to an attached computer or printer via the interface.

3. Log to Memory and Interface

The measurement data is saved in SevenMulti™ and transferred to an attached computer or printer via the interface.

2. Manual Data Transfer to Memory

Automatic measurement-data transfer is deactivated. If you would like to store the measured values after a measurement, press **Data** (see Section 3.4.2 Operation of the **Data**-Menu).

7. Activate Rondolino Sample Changer

1. Measurement

If you want to start the measurement with the sample changer using the currently displayed settings:

– Press **Start**. The measurement with the sample changer starts.

If you want to change the sample IDs:

– Press **Edit**. The input window to enter the sample IDs of the first 5 Rondolino positions appears.

– Enter the sample ID using the alphanumeric keypad or the barcode reader.

– Change to the next Rondolino position using ↓. Up to 9 Rondolino positions can be entered. The number of the entered sample IDs determines the number of samples to be measured.

– Press **Save** to confirm the last entry. A table with the data entered appears.

– Press **Start**. The measurement with the sample changer starts.

Notes

- A METTLER TOLEDO titration stirrer can be connected using the Seven/Rondolino Stirrer Driver accessories. This allows fully-automatic measurement with a high rate of repeatability.
- If you have selected log to interface, the data is transferred after each individual measurement. If you have selected log to memory, the data is saved as in a normal measurement.

8. mV/rel. mV Methods in Memory

A total of 40 methods for all applications can be stored.

1. Load a Stored Method from Memory

A list of the names of stored measurement methods appears on the screen.

– Select the desired method with the arrow keys.

– Display the parameters of the selected method with **Select**.

– Press **Load** to load the parameters for the subsequent measurements.

2. Save Current Settings as a Method

The current settings for the measurement are displayed.

– Press the **Save** key.

The input window for entry of the name of the measurement method appears.

– When the name has been entered, press **Save** again to store the measurement method.

– A method ID cannot be used twice. It must first be deleted before it can be used again. Otherwise the **Method ID already exists** error message appears.

9. rel. mV Offset Setting

Note: You can only set this in the rel. mV menu.

1. Enter an Offset Value

The input window for the offset appears.

– Enter offset in mV and save with **Save**.

2. Test a Reference Sample

You are directed to place the electrode into the reference solution.

– Once the electrode is placed in the reference solution, start measuring with **Meas.**.

– When the measurement display freezes, save the measured value with **Save**.

6.2.3 Measuring absolute potential (mV value)

Calling up mV mode

– Press **Mode** in the measurement display. Then press **mV** in the following menu.
The measurement display is now in mV.

Performing measurement

– Place the electrode into the sample and press **Read**.

– Depending on the set endpoint, wait until the measurement display stops moving or press **Read** to complete the measurement.

– Press **Read** again to start a new measurement.

Note: Calibration is not possible in mV mode.

6.2.4 Measuring relative potential (rel. mV value)

Calling up rel. mV mode

– Press **Mode** in the measurement display. Then press **Rel.mV** in the following menu.
  The measurement display is now in mV.
  The measured or entered offset is subtracted automatically.

Reading offset

– Call up the rel. mV menu with **Menu** and confirm **9. Offset Setting** with **Enter**.
– Select **2. Test a Reference Sample** and confirm with **Enter**.
– Place electrode into the reference sample.
– Start the reference measurement with **Meas.** and wait until the measurement display freezes.
– Press **Save** to accept the offset.
– Press **Exit** to cancel the measurement.

Entering offset manually

– Call up the rel. mV menu with **Mode** and confirm **9. Offset Setting** with **Enter**.
– Confirm **1. Enter an Offset Value** with **Enter**.
– Enter offset in mV (–1999.9 … + 1999.9 mV).
– Prss **Save** to accept the offset.
– Press **Exit** to cancel the input.

Measuring relative potential

– Place the electrode into the sample and press **Read**.
  The relative potential at the electrode is displayed in mV in the display.
  Depending on the set endpoint, wait until the measurement display freezes or press **Read** to complete the measurement.
– Press **Read** again to start a new measurement.

Note: Calibration is not possible in rel. mV mode.

6.3 The Ion mode

6.3.1 Menu structure of the Ion mode

In addition to the ion mode, the Ion expansion unit also allows you to measure pH, mV and rel. mV. Descriptions of the pH and mV/rel. mV menus are found in Sections 6.1 The pH mode and 6.2. The mV/rel. mV mode.

1. Measurement Unit and Stability Criterion Page 45

1. Select Measurement Units
   1. mmol/L
   2. mol/L
   3. ppm
   4. mg/L
   5. %
2. Select Stability Criterion
   1. Fast
   2. Normal
   3. Strict

2. Calibration Setting Page 45

1. Set Calibration Standard
   1. mmol/L
   2. mol/L
   3. ppm
   4. mg/L
   5. %
2. Select Calibration Mode
   1. Segment Method
   2. Linear Method
3. Set Calibration Reminder
   1. Off
   2. Remind by Interval Time

3. Incremental Methods Page 46

1. Known Addition
2. Known Subtraction
3. Sample Addition
4. Sample Subtraction

4. Select Endpoint Formats Page 48

1. Auto
2. Manual
3. Timed

5. Set MTC Temperature Page 48

6. Set Alarm Limits Page 48

1. Ion Concentration Max. Limit
2. Ion Concentration Min. Limit
3. Temperature Max. Limit
4. Temperature Min. Limit
5. Calibration Slope Max. Limit
6. Calibration Slope Min. Limit

7. Timed Interval Readings Page 49

1. On
   1. Log to Memory
   2. Log to Interface
   3. Log to Memory and Interface
2. Off

8. Select Data Transfer Mode Page 49

1. Automatic Data Transfer
   1. Log to Memory
   2. Log to Interface
   3. Log to Memory and Interface
2. Manual Data Transfer to Memory

9. Activate Rondolino Sample Changer Page 50

1. Measurement
2. Calibration

10. Ion Methods in Memory Page 51

1. Load a Stored Method from Memory
2. Save Current Settings as a Method

6.3.2 Operation of the Ion menu

– If two expansion units are attached, first ensure that the desired expansion unit is selected.
– Press **Mode** and press **Ion** in the menu that appears to select the ion mode.
– Call up the Ion menu with **Menu**.

1. Measurement Unit and Stability Criterion

1. Select Measurement Units

In this menu you can define the unit (mmol/L, mol/L, ppm, mg/L oder %) for measurements and calibration.

– Afterward you can change to mmol/L and mol/L units or ppm, mg/L and % using the menu item **1.1. Measurement setting**.

Note: If, for example, you wanted to change from mol/L units to ppm, you must first recalibrate otherwise an error message appears.

2. Select Stability Criterion

In this menu you can define the stability criterion of your measurement

Stability criterion for fast
The measured signal may not change by more than 0.3 mV in 4 seconds.

Stability criterion for normal
The measured signal may not change by more than 0.08 mV in 8 seconds.

Stability criterion for strict
The measured signal may not change by more than 0.03 mV in 12 seconds or by more than 0.08 mV in 26 seconds

2. Calibration Setting

1. Set Calibration Standard

You can define the calibration standards here:

– Select the unit and press **Enter** to access the table for entering temperature values and ion concentrations.
– Enter values using the alphanumeric keypad, use ↓ to navigate within the table and ← to delete.
– Press **Save** to end the editing the table and accept the values.

2. Select Calibration Mode

1. Segmented Method
The segmented method is the most modern method for precise Ion measurements. The calibration curve is made up of line segments joining the individual calibration points rather than a linear regression through them. Non-linear behavior frequently occurs at low ion concentrations. The segmented method is preferred for high-precision measurements.

2. Linear Method
With this method, the calibration curve is determined via a linear regression line. The linear method should only be used at higher concentrations where the calibration curve is still mainly linear.

3. Set Calibration Reminder

1. Off – no calibration reminder

2. Remind by Interval Time

If the calibration reminder is active, you are reminded to perform a new calibration after a specified amount of time has passed. The reminder comes in the form of a message on the bottom line of the measurement display.

Activating this item leads to an input window, into which you enter the time interval (1 to 1000 h).

3. Incremental Methods

Incremental readings are especially useful when individual analyses are to be carried out, as only one solution and two potential measurements are necessary. Calibration need only be performed before the first reading with the sensor, as the slope of the sensor generally remains the same for several months.

1. Known Addition

For the known addition, the potential of a sample with a known volume is measured. After a small, known volume (increment) of a standard with a known concentration is added, the potential is measured again and the concentration of the sample is calculated using the following formula:

$$C_{Sample} = (C_{STD} \cdot V_{STD}) / ((V_{Sample} + V_{STD}) \cdot 10^{\Delta E/S} - V_{Sample})$$

whereas

C_{Sample} = desired concentration of sample in the selected unit U, e.g. ppm

C_{STD} = known concentration of the standard (U)

V_{STD} = known volume of the standard (mL)

V_{Sample} = known volume of the sample (mL)

ΔE = change of the mV signal after addition of the standard increment (mV)

S = slope of the sensor being used (mV/pX), saved in the instrument

A table with the current values for the following parameters appears:

V (sample) volume of the sample in mL

V (stand) volume of calibration standard in mL

C (stand) concentration of the ion to be determined in the calibration standard (unit selected as before)

2. Known Subtraction

For the known subtraction, the potential of a sample with a known volume is measured. A small, known volume (increment) of a standard solution of a substance different from the measured ion, and which forms a precipitate with low solubility with the measured ion, is then added. This leads to a measurable decrease in the measured ion concentration. The potential is measured again and the concentration of the sample calculated using the following formula:

$$C_{Sample} = (C_{STD} \cdot V_{STD}) / (V_{Sample} - (V_{Sample} + V_{STD}) \cdot 10^{\Delta E/S})$$

Legends and setting options as with 1. Known Addition.

3. Sample Addition

With the sample addition, the potential of a highly-diluted solution with a known volume and concentration is measured. A small, known volume (increment) of a sample is added, and the potential is measured again. The concentration of the sample is calculated using the following formula:

$C_{Sample1} = C_{STD1} \cdot (((V_{Sample1} + V_{STD1})/V_{Sample1}) \cdot 10^{\Delta E1/S} - V_{STD1}/V_{Sample1})$

whereas

$C_{Sample1}$ = desired concentration of the sample, determined via sample addition

C_{STD1} = known concentration of the solution before addition of the first sample increment

V_{STD1} = known volume of the solution before addition of the first sample increment

$V_{Sample1}$ = known volume of the sample before addition of the first sample increment

Δ_{E1} = change of the mV signal after addition of the first sample increment

Up to 4 sample increments of the same volume can be added for one reading. This yields 4 results, which should theoretically be the same. When calculating the desired concentration of the sample after the second sample addition, the same formula as above is used, but with the following solution concentration and volume:

$C_{STD2} = (C_{STD1} \cdot V_{STD1} + C_{Sample1} \cdot V_{Sample1}) / (V_{STD1} + V_{Sample1})$

$V_{STD2} = V_{STD1} + V_{Sample1}$

$\Delta E2$ = change of the mV signal after addition of the second sample increment.

The third and fourth sample additions are performed accordingly.

A table with the current values for the following parameters appears:

C (Stand)	concentration of the ion to be determined in the calibration standard (unit selected as usual)
V (Stand)	volume of calibration standard in mL
V(Sample1)	volume of the first sample increment or the first thinning in mL
V(Sample2)	volume of the second sample increment or the second thinning in mL
V(Sample3)	volume of the third sample increment or the third thinning in mL
V(Sample4)	volume of the fourth sample increment or the fourth thinning in mL

Parameter entry occurs as described under 1.1. Known Addition

4. Sample Subtraction

With the sample subtraction, the potential of a highly-diluted solution with a known volume and concentration is measured. A small known volume (increment) of a sample solution which forms a precipitate with the measured ion with low solubility is then added. The electrode responds to the standard, but not to the sample to be determined. The potential is measured again and the concentration of the sample calculated using the following formula:

$C_{Sample1} = C_{STD1} \cdot (V_{STD1}/V_{Sample1} - (V_{Sample1} + V_{STD1})/V_{Sample1}) \cdot 10^{\Delta E1/S})$

Legend and setting options the same as with 3. Sample Addition, see above.

4. Select Endpoint Formats

1. Auto

With the automatic endpoint the selected stability criterion determines the end of an individual reading depending on the behavior of the sensor used. This ensures an easy, quick and precise measurement.

– Start measurement with **Read**.
  The measurement ends automatically when the measured value is stable.

2. Manual

– Start measurement with **Read**.

– End the measurement by pressing **Read** again.

3. Timed

With the timed endpoint, measurement is started with **Read**. The measurement is ended automatically when the set time period expires.

You set this time period (3 s to 3600 s) in the following input window.

Information on the display

The following symbols appear on the display, depending on the endpoint setting:

Preselected format	Start of measurement	Signal stability	Endpointed measurement [1]
Auto endpoint	A	A	A
	A	**Read** ⟹	M
Manual endpoint	M	**Read** ⇨	M
	M	**Read** ⟹	M
Timed endpoint	T	⇨	T
	T	**Read** ⟹	M

[1] The actual endpoint format (last column) not the preselected is stored with the data.

5. Set MTC Temperature (manual temperature compensation)

If you are performing ion measurements and not using a temperature sensor, enter the temperature of the sample (–30 °C ... 130 °C) in this menu. SevenMulti™ uses this temperature to calculate the correct value of the electrode slope for this temperature and shows the temperature-compensated ion value on the measurement display.

6. Set Alarm Limits

In this menu, you can define the upper and lower limits for measurement or calibration data. If a limit is exceeded or undershot, a warning is output to the screen. This message also appears on the GLP printout.

Before entering a limit, you can activate or deactivate the alarm for this limit.

Parameter	Minimum	Maximum	Unit
Ion Concentration	1.00e-09	9.99e+09	mmol/L
	1.00e-09	9.99e+09	mol/L
	0.001	9999	ppm
	1.00e-09	9.99e+09	mg/L
	0.001	999.9	%
Temperature	–30.0	130.0	°C
Calibration Slope	85.0	110.0	%

7. Timed Interval Readings

In this menu, you activate and deactivate series measurements and set the time interval between two successive measurements.

1. On

The input window for the time interval (3 s to 2400 s) appears.
When the time interval is entered, a menu appears for selection of the mode of measured data recording:

1. Log to Memory

The measured data is saved in the SevenMulti™ memory.

2. Log to Interface

The measured data is transferred to an attached computer or printer via the interface.

3. Log to Memory and Interface

The measurement data is saved in SevenMulti™ and transferred to an attached computer or printer via the interface.

2. Off – no series measurement

6. Select Data Transfer Mode

1. Automatic Data Transfer

1. Log to Memory

The measured data is saved the in SevenMulti™ memory.

2. Log to Interface

The measured data is transferred to an attached computer or printer via the interface.

3. Log to Memory and Interface

The measurement data is saved in SevenMulti™ and transferred to an attached computer or printer via the interface.

2. Manual Data Transfer to Memory

Automatic measurement-data transfer is deactivated. If you would like to store the measured values after a measurement, press **Data** (see Section 3.4.2 Operation of the **Data**-Menu).

9. Activate Rondolino Sample Changer

1. Measurement

If you want to start the measurement with the sample changer using the currently displayed settings:

– Press **Start**. The measurement with the sample changer starts.

If you want to change the sample IDs:

– Press **Edit**. The input window to enter the sample IDs of the first 5 Rondolino positions appears.

– Enter the sample ID using the alphanumeric keypad or the barcode reader.

– Change to the next Rondolino position using ↓. Up to 9 Rondolino positions can be entered. The number of the entered sample IDs determines the number of samples to be measured.

– Press **Save** to confirm your last entry. A table with the data entered appears.

– Press **Start**. The reading with the sample changer starts.

2. Calibration

– The current standards are displayed.

– To change the buffer group, exit the Rondolino menu and redefine the standards in the Calibration setting menu.

– Enter the number of standards and press **Save** to confirm the entry.

– Press **Start**. After the last reading a table appears showing the results of the calibration.

– To assess the calibration, press **Graph** to display the calibration curve (mV vs. ion concentration) graphically.

• The calibration points are shown as crosses.

• In the segment method, the calibration points are joined by straight lines.

• In the linear method the calibration curve is calculated as a linear regression.

– To use the calibration for further readings: press **Save**.

– To discard the calibration: press **Cancel**.

Notes

• A METTLER TOLEDO titration stirrer can be connected using the Seven/Rondolino Stirrer Driver accessories. This allows fully-automatic measurement with a high rate of repeatability.

• For readings: If you have selected log to interface, the data is transferred after each individual measurement. If you have selected save data, the data is saved as in a normal measurement.

10. Ion Methods in Memory

A total of 40 methods for all applications can be stored.

1. Load a Stored Method from Memory

A list of the names of stored measurement methods appears on the screen.

– Select the desired method with the arrow keys.

– Display the parameters of the selected method with **Select**.

– Press **Load** to load the parameters for the subsequent measurements.

2. Save Current Settings as a Method

The current settings for the reading are displayed.

– Press the **Save** key.

The input window for entry of the name of the measurement method appears.

– When the name has been entered, press **Save** again to store the measurement method.

– A method ID cannot be used twice. It must first be deleted before it can be used again. Otherwise the **Method ID already exists** error message appears.

6.3.3 Measuring ion concentration

Notes

- To ensure precise ion concentration measurements, perform a calibration before each series of measurements (see Section 6.3.2 Operation of the Ion menu).
- Temperature dependencies cannot be programmed for the reference solutions. For this reason, the warning **Measured temperature differs from setting** appears if the temperature deviates from the specification by more than 0.5 °C during calibration.

– Attach a suitable ion-sensitive electrode to the Ion expansion unit.

– If the electrode does not have a temperature sensor, set the MTC temperature (see Ion menu **5. Set MTC Temperature**) or use a separate Pt1000 or NTC 30 kΩ temperature sensor.

– Place the electrode in the sample and press **Read**.
The ion concentration of the sample is shown on the display.
The unit of the measurement result depends on the parameters set under **2. Calibration setting**.

6.3.4 Calibrating an ion-sensitive electrode

Preparing for calibration

– Have a set of calibration standards with known ion concentrations on hand.
  A maximum of 9 different calibration standards is possible.
– After entering of a new sensor ID and sensor SN, select the electrode type.
– Enter parameters of the calibration standards in the Ion menu under **1.2. Calibration Setting**.

Performing calibration

– Place electrode into the first calibration standard and press **Cal** to start calibrating.
  CAL 1 on the display indicates that the first calibration point is being measured.
  If a standard other than the selected one is to be used, it can still be changed using the key.
  Depending on the endpoint format selected, the value is shown when the measured value is stable.
– Place electrode into the second calibration standard and press **Cal** to start calibrating again.
  CAL 2 on the display indicates that the second calibration point is being measured.
  Depending on the endpoint format selected, the value is shown when the measured value is stable.
– Repeat this procedure for further calibration standards.
– End the calibration with **End** after measurement of the last calibration standard.
  A table with the calibration results appears on the display.

Checking calibration

– To gauge the calibration, display the calibration curve (mV vs. ion concentration) graphically with **Graph.** The calibration points are displayed as crosses, or, with the segment method, via straight lines.
– Press **Save** to accept the calibration for subsequent measurements.
– Press **Cancel** to disgard the calibration.

Notes

- For a single-point calibration, the theoretical value of the ion to be determined is always used for the slope, e.g. –59.16 mV/pH for H^+, 59.16 mV/pF for F^- or –29.58 mV/pX for Ca^{2+}. If you perform a 1-point calibration using a sensor ID with which you have already performed a multi-point calibration, only the offset value is changed. The slope of the previous multi-point calibration is retained.
- If the same solution is used twice for an n-point calibration, the warning **Wrong standard** appears for the second measurement.
- If the temperature of the ion solution deviates by more than 0.5 °C from the specified value, the warning **Measured temp. differs from setting** appears.
- Ensure that the calibration standards have the same temperature during calibration as the samples will later on during measurement.

6.3.5 Incremental measurement

Performing incremental measuring

– Select the desired incremental measurement method and confirm with **Enter**.

1. Known Addition
2. Known Subtraction
3. Sample Addition
4. Sample Subtraction

– Press **Start** if you want to use the **current parameters** for your measurement.

– You are requested to place the electrode into the first solution. Start the reading with **Meas.** The measurement display appears until the first reading is complete.

– You are then directed to place the electrode into the second solution and to start reading again with **Meas.**. This procedure is repeated until all of the solutions designated by the measurement method have been read.

– At the end of the procedure the results are saved in the database or transferred to a printer or PC depending on the selected data transfer mode.

– If you would like to **change the parameters**, press **Edit**. The following table appears:

V(sample)	
V(stand.)	
C(stand.)	

– Enter the selected parameters using the alphanumeric keypad and press **Save** to confirm. Press **Start** to start your measurement.

– If you want to use an **existing incremental method**, press **Load**. The existing incremental methods in the database will be displayed.

– Press **Load** to select a method. Press **Start** to begin the measurement.

Example: Sample Addition

– Place electrode into the calibration standard and press **Meas.**.
The first measurement starts automatically.
When the measurement is complete, you will be directed to place the electrode into the second solution.

– Add the specified volume of sample solution to the calibration standard and mix the solution.

– Place electrode into the solution and press **Meas.**.
The measurement starts automatically.
When the measurement is complete, you will be directed to place the electrode into the third solution.

– Repeat this procedure for the further sample additions, (max. 4).

When all additions have been measured, the calculated concentration of the sample solution after each addition is displayed and can be printed or transferred to a computer.

6.4 The ISFET expansion unit

Besides the ISFET mode, the ISFET expansion unit also offers the possibility of measuring in mV and rel. mV. The description of the mV/rel. mV menu can be found in Section 6.2 The mV/rel. mV mode.

6.4.1 Menu structure of the ISFET expansion unit

1. Calibration Setting Page 30

- **1.** Set Calibration Buffer
  - **1.** Select a Standard Buffer Group
  - **2.** Set a Customized Buffer Group
- **2.** Select Calibration Mode
  - **1.** Segment method
  - **2.** Linear method
- **3.** Set Calibration Reminder
  - **1.** Off
  - **2.** Remind by Interval Time

2. Offset Test Page 55

3. Select Resolution and Stability Criterion Page 32

- **1.** Select Display Resolution
  - **1.** X.X
  - **2.** X.XX
  - **3.** X.XXX
- **2.** Select Stability Criterion
  - **1.** Fast
  - **2.** Normal
  - **3.** Strict

4. Select Endpoint Formats Page 33

- **1.** Auto
- **2.** Manual
- **3.** Timed

5. Set MTC Temperature Page 33

6. Set Alarm Limits Page 55

- **1.** pH Max. Limit
- **2.** pH Min. Limit
- **3.** Temperature Max. Limit
- **4.** Temperature Min. Limit
- **5.** Calibration Offset Max. Limit
- **6.** Calibration Offset Min. Limit
- **7.** Calibration Slope Max. Limit
- **8.** Calibration Slope Min. Limit

7. Timed Interval Readings Page 34

- **1.** On
  - **1.** Log to Memory
  - **2.** Log to Interface
  - **3.** Log to Memory and Interface
- **2.** Off

8. Select Data Transfer Mode Page 34

- **1.** Automatic Data Transfer
  - **1.** Log to Memory
  - **2.** Log to Interface
  - **3.** Log to Memory and Interface
- **2.** Manual Data Transfer to Memory

9. Activate Rondolino Sample Changer Page 35

- **1.** Measurement
- **2.** Calibration

10. ISFET Methods in Memory Page 36

- **1.** Load a Stored Method from Memory
- **2.** Save Current Settings as a Method

6.4.2 Operation of the ISFET menu

– If two expansion units are attached, first ensure that the desired expansion unit is selected.
– Call up the ISFET menu with **Menu**.

The operation of the ISFET menu corresponds to operation of the pH menu except for point 2. Offset and 6. Set alarm limits. A detailed description can be found in Section 6.1.2 Operation of the pH menu pages 30 to 36.

2. Offset Test

You are directed to place the electrode into a calibration buffer of pH 7.0.

– Place the ISFET electrode into the calibraione buffer of pH-7.0 and start the offset measurement with **Meas.**.
  The offset of the electrode is automatically measured and adjusted.

6. Set Alarm Limits

In this menu, you can define the upper and lower limits for measurement or calibration data. If a limit is exceeded or undershot, a warning is output to the screen. This message also appears on the GLP printout.

Before entering a limit, you can activate or deactivate the alarm for this limit.

Parameter	Minimum	Maximum	Unit
pH value	0.000	14.000	pH
Temperature	–30.0	130.0	°C
Calibration offset	–60.0	60.0	mV
Calibration slope	75.0	110.0	%

6.4.3 Measuring with the ISFET expansion unit

The ISFET expansion unit is used exclusively for pH, mV and rel. mV readings with sensors based on **I**on-**S**ensitive **F**ield **E**ffect **T**ransistors.

– **Measuring pH values**

Note: To ensure precise pH-value measurements, perform a calibration before each series of measurements (see Section 6.1.2 Operation of the pH menu) and adjust the offset regularly (see Section 6.4.2 Operation of the ISFET menu).
With a new ISFET electrode, the offset must be adjusted with a calibration buffer of pH 7.0 before the sample reading, as the offset can vary considerably.

– Attach a suitable ISFET electrode to the ISFET expansion unit.
– Place the ISFET electrode into the sample and press **Read**.
  The pH value of the sample is shown on the display.

Preparing for calibration

– Have a set of calibration buffers on hand.
  At least 2 calibration buffers with different pH values are required, and max. 9 different calibration buffers are possible.
– Enter the parameters of the calibration buffer in the ISFET menu under **1.1. Select a Standard Buffer Group.**

Performing calibration

– Place the electrode in the first calibration buffer and press **Cal** to start calibrating.
  CAL 1 on the display indicates that the first calibration point is being measured.
  If a standard other than the selected one is to be used, it can still be changed using the key.
  Depending on the endpoint format selected, the value is shown when the measured value is stable.
– Place electrode into the second buffer and press **Cal** to continue calibrating.
  CAL 2 in the display indicates that the second calibration point is being measured.
  Depending on the endpoint format selected, the value is shown when the measured value is stable.
– Repeat this procedure for further calibration buffers.
– End calibration with **End** after measurement of the last calibration buffer.
  A table with the calibration results appears on the display.

Checking calibration

– To gauge the calibration, display the calibration curve (mV vs. pH) graphically with **Graph.**.
  The calibration points are displayed as crosses.
  With the segment method, the calibration points are connected by straight lines.
– Press **Save** to accept the calibration for subsequent measurements.
– Press **Cancel** to disgard the calibration.

7. The Conductivity expansion unit

In addition to conductivity measurement, the conductivity expansion unit allows the measurement of TDS, salinity and resistivity. The menus for these measurement types are described in the following.

7.1 The conductivity mode

7.1.1 Menu structure of the conductivity mode

1. Measurement Setting Page 58

1. Select Reference Temperature
2. Select Temp. Correction Method/USP/EP
   1. Linear Correction
   2. Non-linear Correction: Natural Water
   3. Off
   4. USP Mode
   5. EP Mode (highly purified water
   6. EP Mode (purified water)
3. Select Measurement Units
   1. Auto Range µS/cm, mS/cm
   2. X.XX E-X S/m

2. Calibration Settings Page 60

1. Set Calibration Standard
   1. 10, 84, 500 & 1413 µS/cm, 12.88 mS/cm
   2. Saturated NaCl
   3. Enter Cell Constant during Calibration
   4. Enter your Special Standard
2. Set Calibration Reminder
   1. Off
   2. Remind by Interval Time

3. Select Endpoint Formats Page 61

1. Auto
2. Manual
3. Timed

4. Set MTC Temperature Page 62

5. Set Alarm Limits Page 62

1. Conductivity Max. Limit
2. Conductivity Min. Limit
3. Temperature Max. Limit
4. Temperature Min. Limit
5. Cell Constant Max. Limit
6. Cell Constant Min. Limit

6. Timed Interval Readings Page 62

1. On
   1. Log to Memory
   2. Log to Interface
   3. Log to Memory and Interface
2. Off

7. Select Data Transfer Mode Page 63

1. Automatic Data Transfer
   1. Log to Memory
   2. Log to Interface
   3. Log to Memory and Interface
2. Manual Data Transfer to Memory

8. Activate Rondolino Sample Changer Page 63

1. Measurement
2. Calibration

9. Analog Output Settings Page 64

1. 20 µS/cm (middle point)
2. 200 µS/cm (middle point)
3. 2 mS/cm (middle point)
4. 20 mS/cm (middle point)
5. 200 mS/cm (middle point)
6. Whole range

10. Conductivity Methods in Memory Page 64

1. Load a Stored Method from Memory
2. Save Current Settings as a Method

7.1.2 Operation of the Conductivity menu

– If two expansion units are attached, first ensure that the desired expansion unit is selected.
– Press **Mode** and press **Cond.** in the menu that appears to select the conductivity mode.
– Call up the Conductivity menu with **Menu**.

1. Measurement Setting

1. Select Reference Temperature

You can select between the reference temperatures 20 °C and 25 °C. The conductivity of the sample is referenced to the selected temperature during measurement.

2. Select Temp. Correction Method/USP/EP

1. Linear Correction

The conductivity of a solution increases when the temperature increases. With most solutions, a linear interrelationship between conductivity and temperature is given. In such cases, select the linear correction method.

1. Enter Temp. Correction Coefficient

The input window for the temperature-correction coefficient (0 – 10 % / °C) appears.

The measured conductivity is corrected and displayed using the following formula:

$G_{TRef} = G_T / (1 + (\alpha(T - T_{Ref}))/100\ \%)$

whereas

G_T = conductivity measured at temperature T (mS/cm)

G_{TRef} = conductivity (mS/cm) displayed by the instrument, calculated back to the reference temperature T_{Ref}

α = linear temperature correction coefficient (%/°C); $\alpha = 0$: no temperature correction

T = measured temperature (°C)

T_{Ref} = Reference temperature (20 °C or 25 °C)

2. Determine Temp. Correction Coefficient

To determine the α coefficient, the sample has to be measured at two different temperatures.

– First measure the sample at a temperature that is different to that of the reference temperature and that is in the typical range of the sample temperature.
– Then measure the sample at the reference temperature.
– A window with the calculated value of α appears. Press **Save** to accept the value. If you exit the menu by pressing **Exit**, the result is discarded.

2. Non-Linear Correction: Natural Water

The conductivity of natural water shows strong non-linear temperature behaviour. For this reason, use the non-linear correction for natural water.

The measured conductivity is multiplied by the factor f_{25} for the measured temperature (see table in appendix) and thus corrected to the reference temperature of 25 °C:

$G_{T25} = G_T \cdot f_{25}$

If another reference temperature is to be used, e.g. 20 °C, the conductivity corrected to 25 °C is divided by 1.116 (see f_{25} for 20.0 °C)

$G_{T20} = (G_T \cdot f_{25}) / 1.116$

Note: Conductivity measurements of natural water can only be performed at temperatures ranging from 0 °C to 36 °C. Otherwise, the warning **Temp. out of nLF correction range** appears.

3. Off

If you switch off temperature correction, the conductivity value at the actual temperature is displayed (α = 0%/°C).

4. USP Mode

In USP mode, SevenMulti™ tests whether the measured conductivity of the water is not greater than the permissible value for "purified water" or "water for injection" at the relevant temperature according to the USP (**U**nited **S**tates **P**harmacopoeia) (see 8.6 USP/EP tables). This is the first step of the USP test.

If the value is lower, the water fulfills the USP requirements. If the value is greater, the warning **Conductivity exceeds USP limit** appears. Then you must proceed in accordance with the second step of the USP test.
If you have more stringent requirements for "purified water" than the USP, you can use the USP factor (10 % to 100 %) to take these into account.
Example: At 15 °C, the water may not exceed a conductivity of 1 µS/cm, in order to fulfill the USP requirements in the first step. A warning appears with a USP factor of 100 % if the measured conductivity is greater than 1 µS/cm. With a USP factor of 80 %, this message appears when the measured conductivity is greater than 0.8 µS/cm.

Note: In the USP mode, temperature correction is automatically switched off (α = 0%/°C).
If GLP-printout is selected the warning **Conductivity exceeds USP limit** also appears on the printout.

5. EP Mode (highly purified water)

In the EP mode (highly purified water) the SevenMulti™ checks whether the measured conductivity of the water is not greater than the value allowed according to EP (**E**uropean **P**harmacopoeia) for "highly purified water" at the temperature concerned, see 8.6 USP/EP tables.

The method corresponds to that described under **4. USP mode**.

Note: In the EP mode, temperature correction is automatically switched off (α = 0%/°C).
If GLP-printout is selected the warning **Conductivity exceeds EP limit** also appears on the printout.

6. EP Mode (purified water)

In the EP mode (purified water) the SevenMulti™ checks whether the measured conductivity of the water is not greater than the value allowed according to EP (**E**uropean **P**harmacopoeia) for "purified water"at the temperature concerned, see 8.6 USP/EP tables.

The method corresponds to that described under **4. USP mode**.

Note: In the EP mode, temperature correction is automatically switched off (α = 0%/°C).
If GLP-printout is selected the warning **Conductivity exceeds EP limit** also appears on the printout.

3. Select Measurement Units

1. Auto Range µS/cm or mS/cm

The display automatically switches to the best measurement range. The measurement unit is adapted to the measured conductivity value.

2. X.XX E-X S/m

The measured value display is given in scientific notation.

S/m	µS/cm
E–6	0.01
E–5	0.1
E–4	1
E–3	10
E–2	100
E–1	1000

S/m	mS/cm
E+0	10
E+1	100
E+2	1000

2. Calibration Settings

1. Set Calibration Standard

1. 10, 84, 500 & 1413 µS/cm, 12.88 mS/cm

1. Auto Standard Recognition On

For automatic standard recognition in the calibration, the nominal cell constant of your conductivity sensor must be known (± 5%).

– An input window appears in which the cell constant (± 5%) of the conductivity sensor used is entered.

2. Auto Standard Recognition Off

If you switch off the automatic standard recognition, you can define the order of the predefined standards yourself.

– A table to enter the order of the standards appears.

– Press **Change** to select a standard. Press ↓ to navigate to the input field.

– Press **Save** to accept the selected standards.

2. Saturated NaCl

3. Enter Cell Constant during Calibration

If the cell constant of the conductivity cell being used is accurately known, you can enter it directly in the SevenMulti™.

– Press **Cal** in the measurement display; the request to enter the cell constant then appears.

4. Enter your Special Standard

If you are using your own conductivity standard for calibration of the conductivity sensor, you can enter the conductivity of the calibration standard in mS/cm in this screen.

Lowest possible special standard: 0.00005 mS/cm. This corresponds to the conductivity of natural water at 25 °C, exclusively caused by the autoprotolysis of water.

For the special standard, you can enter up to 5 temperature-dependent values in the table.
Use ↓ ↑ to navigate within the table, delete using ← and press **Save** to save the values.

2. Set Calibration Reminder

1. Off – no calibration reminder

2. Remind by Interval Time

If the calibration reminder is active, you are reminded to perform a new calibration after a specified amount of time has passed. The reminder comes in the form of a message on the bottom line of the measurement display.
Activating this item leads to an input window, into which you enter the time interval (1 to 1000 h).

3. Select Endpoint Formats

1. Auto

With the automatic endpoint, special algorithms determine the end of an individual measurement, depending on the behaviour of the sensor used. This ensures an easy, quick and precise measurement.

– Start reading with **Read**.
The reading ends automatically when the measured value is stable.

Stability criterion for conductivity measurements
The endpoint is taken when the measured conductivity differs by less than 0.4 % from the average over the last 6 seconds.

2. Manual

– Start measurement with **Read**.

– End the measurement by pressing **Read** again.

3. Timed

With the timed endpoint, measurement is started with **Read**. The measurement is ended automatically when the set time period expires.

You set this time period (3 s to 3600 s) in the following input window.

Information on the display

The following symbols appear on the display, depending on the endpoint setting :

Preselected format	Start of measurement	Signal stability	Endpointed measurement [1]
Auto endpoint	A	Ā	Ā
	A	**Read** ⟹	M̄
Manual endpoint	M	⌒ **Read** ⇨	M̄
	M	**Read** ⟹	M̄
Timed endpoint	T	⌒ 🕓 ⇨	T̄
	T	**Read** ⟹	M̄

[1] The actual endpoint format (last column) not the preselected is stored with the data.

4. Set MTC Temperature (manual temperature compensation)

If you are working without a temperature sensor during the conductivity measurement, enter the temperature of the sample in this menu (–30 °C … 130 °C). The SevenMulti™ uses this temperature to calculate the conductivity value based on the selected reference temperature.

5. Set Alarm Limits

In this menu, you can define the upper and lower limits for measurement or calibration data. If a limit is exceeded or undershot, a warning is output to the screen. This message also appears on the GLP printout.

Before entering a limit, you can activate or deactivate the alarm for this limit.

Parameter	Minimum	Maximum	Unit
Conductivity	0.000	1100.000	mS/cm
Temperature	–30.0	130.0	°C
Cell Constant	0.000001	200.0	1/cm

6. Timed Interval Readings

In this menu, you activate and deactivate series measurements and set the time interval between two successive measurements.

1. On

The input window for the time interval (3 s to 2400 s) appears.
When the time interval is entered, a menu appears for selection of the mode of measured data recording:

1. Log to Memory

The measured data is saved in the SevenMulti™ memory.

2. Log to Interface

The measured data is transferred to an attached computer or printer via the interface.

3. Log to Memory and Interface

The measurement data is saved in SevenMulti™ and transferred to an attached computer or printer via the interface.

2. Off – no series measurement

7. Select Data Transfer Mode

1. Automatic Data Transfer

1. Log to Memory

The measured data is saved the in SevenMulti™ memory.

2. Log to Interface

The measured data is transferred to an attached computer or printer via the interface.

3. Log to Memory and Interface

The measurement data is saved in SevenMulti™ and transferred to an attached computer or printer via the interface.

2. Manual Data Transfer to Memory

Automatic measurement-data transfer is deactivated. If you would like to store the measured values after a reading, press **Data** (see Section 3.4.2 Operation of the **Data**-Menu).

8. Activate Rondolino Sample Changer

1. Measurement

If you want to start the measurement with the sample changer using the currently displayed settings:

– Press **Start**. The measurement with the sample changer starts.

If you want to change the sample IDs:

– Press **Edit**. The input window to enter the sample IDs of the first 5 Rondolino positions appears.

– Enter the sample ID using the alphanumeric keypad or the barcode reader.

– Change to the input window of the next Rondolino position using ↓. Up to 9 Rondolino positions can be entered. The number of sample IDs entered determines the number of samples to be measured.

– Press **Save** to confirm the last entry. A table with the data entered appears.

Press **Start**. The measurement with the sample changer starts.

2. Calibration

– The current standards are displayed.

– To change the standards, exit the Rondolino menu and redefine the standards in the menu **Calibration setting**.

– Enter the number of standards and press **Save** to confirm your entry.

– Press **Start**. After the last measurement a table appears showing the cell constants.

Notes

- A METTLER TOLEDO titration stirrer can be connected using the Seven/Rondolino Stirrer Driver accessories. This allows fully-automatic measurement with a high rate of repeatability.
- For measurements: If you have selected log to interface, the data is transferred after each individual reading. If you have selected log to memory, the data is saved as in a normal reading.

9. Analog Output Setting

The conductivity expansion unit has a separate analog output, where the conductivity measurement is converted into a voltage. In contrast to a common analog output on the SevenMulti™, the analog signal at the conductivity expansion unit is temperature compensated.

With this menu, you can set the sensitivity of the analog output of the conductivity expansion unit for a titration unit. The output voltage depends on the measurement range.

The following values are available for the mean output voltage at the analog output:

No.	Mean value	Meas. range 18 – 180 mV	Meas. range 180 – 1800 mV
1.	20 µS/cm	2 – 20 µS/cm	20 – 200 µS/cm
2.	200 µS/cm	20 – 200 µS/cm	0.2 – 2 mS/cm
3.	2 mS/cm	0.2 – 2 mS/cm	2 – 20 mS/cm
4.	20 mS/cm	2 – 20 mS/cm	20 – 200 mS/cm
5.	200 mS/cm	20 – 200 mS/cm	200 – 2000 mS/cm
6.	Whole Range (Values see table below)		

Whole Range
The following voltages are provided at the analog output in this setting:

Measurement range	Voltage range
1 µS/cm – 10 µS/cm	0 – 300 mV
10 µS/cm – 100 µS/cm	300 – 600 mV
100 µS/cm – 1 mS/cm	600 – 900 mV
1 mS/cm – 10 mS/cm	900 – 1200 mV
10 mS/cm – 100 mS/cm	1200 – 1500 mV
100 mS/cm – 1 S/cm	1500 – 1800 mV

10. Conductivity Methods in Memory

A total of 40 methods for all applications can be stored.

1. Load a Stored Method from Memory

A list of the names of stored measurement methods appears on the screen.

– Select the desired method with the arrow keys.

– Display the parameters of the selected method with **Select**.

– Press **Load** to load the parameters for the subsequent measurements.

2. Save Current Settings as a Method

The current settings for the measurement are displayed.

– Press the **Save** key.
The input window for entry of the name of the measurement method appears.

– When the name has been entered, press **Save** again to store the measurement method.

– A method ID cannot be used twice. It must first be deleted before it can be used again. Otherwise the **Method ID already exists** error message appears.

7.1.3 Measuring conductivity

Note: If the conductivity sensor is changed, calibration **must** be performed again, as each sensor has a different cell constant.

– Attach a suitable conductivity sensor to the Conductivity expansion unit.

– If the conductivity sensor does not have a temperature sensor, enter the sample temperature manually (see Conductivity menu **4. Set MTC Temperature**).

– Place the conductivity sensor into the sample and press **Read**.
The conductivity of the sample is shown on the display.

7.1.4 Calibrating a conductivity sensor

The conductivity sensor can be calibrated in 2 ways:

1. Calibration with a conductivity standard.
2. Entry of the cell constant (see section 7.1.2 Operation of the Conductivity menu).

Preparing for calibration

– Have pre-fabricated or your own conductivity standard on hand.

– In the Conductivity menu under **2.1. Set Calibration Standard** or enter the conductivity of the conductivity standard.

Performing calibration

– Place sensor into the conductivity standard and press **Cal**, to start calibrating.
CAL on the screen indicates that the calibration is being carried out. If you have activated automatic standard recognition, SevenMulti™ automatically recognizes the predefined standards.
If a standard other than the selected one is to be used, it can still be changed using the key.
Depending on the endpoint format selected, the value is displayed when the measured value is stable.

If you want to calibrate with one conductivity standard:

– End calibration with **End**. The value of the calculated cell constant (unit: 1/cm) is shown on the display.

– Press **Save** to accept the calibration and adjust the stored cell constant for subsequent measurements.

– Press **Cancel** to disgard the calibration.

If you want to calibrate over a wide conductivity range with several standards:

– Place the sensor in a new standard and press **Cal** again.
  Depending on the endpoint format selected, the value is displayed when the measured value is stable.
– Repeat these steps for further standards.
– Press **End** to end the calibration. On the screen the values of the determined cell constants in the different conductivity ranges are displayed.
– Press **Save** to accept the calibration and adjust the stored cell constant for subsequent measurements.
– Press **Cancel** to disgard the calibration.

Notes

- Calibration with the conductivity standard programmed in the instrument can only be performed at a temperature of 0 °C to 35 °C. Otherwise, the warning **Standard temp. out of range** appears.
- The value 0 S/m for a specific resistivity tending toward infinity is permanently programmed in the SevenMulti™.

7.2 The TDS mode

7.2.1 Menu structure of the TDS mode

1. Measurement Setting Page 68

1. Select Reference Temperature
2. Select Temp. Correction Method
   1. Linear Correction
   2. Non-linear Correction: Natural Water
   3. Off
3. Set TDS Factor

2. Calibration Settings Page 60

1. Set Calibration Standard
   1. 10, 84, 500 & 1413 µS/cm, 12.88 mS/cm
   2. Saturated NaCl
   3. Enter Cell Constant during Calibration
   4. Enter your Special Standard
2. Set Calibration Reminder
   1. Off
   2. Remind by Interval Time

3. Select Endpoint Formats Page 61

1. Auto
2. Manual
3. Timed

4. Set MTC Temperature Page 62

5. Set Alarm Limits Page 69

1. TDS Max. Limit
2. TDS Min. Limit
3. Temperature Max. Limit
4. Temperature Min. Limit
5. Cell Constant Max. Limit
6. Cell Constant Min. Limit

6. Timed Interval Readings Page 62

1. On
   1. Log to Memory
   2. Log to Interface
   3. Log to Memory and Interface
2. Off

7. Select Data Transfer Mode Page 63

1. Automatic Data Transfer
   1. Log to Memory
   2. Log to Interface
   3. Log to Memory and Interface
2. Manual Data Transfer to Memory

8. Activate Rondolino Sample Changer Page 63

1. Measurement
2. Calibration

9. TDS Methods in Memory Page 64

1. Load a Stored Method from Memory
2. Save Current Settings as a Method

7.2.2 Operation of the TDS menu

TDS is the concentration of dissolved solids which pass through a filter with a pore size of 0.45 micrometers. These are typically the following components: carbonate, bicarbonate, chloride, sulfate, phosphate, nitrate, calcium, magnesium, sodium, organic ions and other ions.

TDS is often viewed as an important quantity for life in water, as a certain ion concentration is essential for organisms. If the value is too high or too low, life is impossible. TDS can also be used for the determination of drinking water quality.

TDS behaves in a linear manner and is directly proportional to the conductivity of a sample.

TDS (mg/L) is calculated by multiplying the conductivity value (mS/cm) by the TDS factor.

– If two expansion units are attached, first ensure that the desired expansion unit is selected.
– Press **Mode** and press **TDS** in the menu that appears to select the TDS mode.
– Call up the TDS menu with **Menu**.

The operation of the TDS menu corresponds to that of the conductivity menu except for items 1. Measurement Setting and 5. Set Alarm limits. A detailed description can be found in Section 7.1.2 Operation of the Conductivity menu on pages 58 to 65.

1. Measurement Setting

1. Select Reference Temperature

You can select between the reference temperatures 20 °C and 25 °C. In the measurement, the TDS value of the sample is referenced to the selected temperature.

2. Select Temp. Correction Method

1. Linear Correction

Since the TDS value is calculated from the conductivity of a solution, you should select a temperature correction method. For most solutions, the relationship between conductivity and temperature is linear. In such cases, select the linear correction method.

1. Enter Temp. Correction Coefficient

The input window for the temperature-correction coefficient (0 – 10 % / °C) appears.

The measured TDS value of the sample is corrected and displayed using the following equation:

$G_{TRef} = G_T / (1 + (\alpha(T - T_{Ref}))/100\ \%)$

whereas

G_T = conductivity measured at temperature T (mS/cm)

G_{TRef} = conductivity (mS/cm) displayed by the instrument, calculated back to the reference temperature T_{Ref}

α = linear temperature correction coefficient (%/°C); $\alpha = 0$: no temperature correction

T = measured temperature (°C)

T_{Ref} = Reference temperature (20 °C or 25 °C)

2. Determine Temp. Correction Coefficient

To determine the α coefficient, the sample has to be measured at two different temperatures.

– First measure the sample at a temperature that is different to that of the reference temperature and that is in the typical range of the sample temperature.

– Then measure the sample at the reference temperature.

– A window with the calculated value of α appears. Press **Save** to accept the value. If you exit the menu by pressing **Exit**, the result is discarded.

2. Non-Linear Correction: Natural Water

The conductivity of natural water shows strong non-linear temperature behaviour. For this reason, use the non-linear correction for natural water.

The measured conductivity is multiplied by the factor f_{25} for the measured temperature (see table in appendix) and thus corrected to the reference temperature of 25 °C:

$G_{T25} = G_T \cdot f_{25}$

If another reference temperature is to be used, e.g. 20 °C, the conductivity corrected 25 °C is divided by 1.116 (see f_{25} for 20.0 °C)

$G_{T20} = (G_T \cdot f_{25}) / 1.116$

Note: Conductivity measurements of natural water can only be performed at temperatures ranging from 0 °C to 36 °C. Otherwise, the warning **Temp. out of nLF correction range** appears.

3. Off

If you switch off temperature correction, the conductivity value is displayed at the actual temperature (α = 0%/°C).

3. Set TDS Factor

TDS is calculated by multiplying the conductivity value by the TDS factor.
The input window for the TDS factor appears.

– Enter factor (between 0.4 and 1.0) and save with **Save**.

5. Set Alarm Limits

In this menu, you can define the upper and lower limits for measurement or calibration data. If a limit is exceeded or undershot, a warning is output to the screen. This message also appears on the GLP printout.

Before entering a limit, you can activate or deactivate the alarm for this limit.

Parameter	Minimum	Maximum	Unit
TDS	0.0001	1000	g/L
Temperature	–30.0	130.0	°C
Cell Constant	0.000001	200.0	1/cm

7.2.3 Measuring total dissolved solids (TDS)

A conductivity measured value can be converted to a total dissolved solids value.

– Press **Mode** in the conductivity display.

– Activate the conversion into the total dissolved solids (TDS) value with **TDS**.

– Press **Menu**, select **1.3 Set TDS Factor** and confirm with **Enter**.

– Enter TDS factor and store with **Save**.

Note: If you change the conductivity sensor, a calibration **must** be performed because every sensor has its own cell constant and the calculation of the TDS value is based on the cell constant. (For calibration see Section 7.1.4 Calibrating a conductivity sensor)

– Attach a suitable conductivity sensor to the Conductivity expansion unit.

– If the conductivity sensor does not have a temperature sensor, enter the sample temperature manually (see TDS Menu **4. Set MTC Temperature**).

– Place the conductivity sensor into the sample and press **Read**.
The TDS value of the sample is shown on the display.

7.3 The Salinity mode

7.3.1 Menu structure of the Salinity mode

1. Measurement Setting Page 72

- **1.** Select Salinity Type
  - **1.** Practical Salinity Scale 1978
  - **2.** Natural Sea Water Scale 1966

2. Calibration Settings Page 60

- **1.** Set Calibration Standard
  - **1.** 10, 84, 500 & 1413 µS/cm, 12.88 mS/cm
  - **2.** Saturated NaCl
  - **3.** Enter Cell Constant during Calibration
  - **4.** Enter your Special Standard
- **2.** Set Calibration Reminder
  - **1.** Off
  - **2.** Remind by Interval Time

3. Select Endpoint Formats Page 61

- **1.** Auto
- **2.** Manual
- **3.** Timed

4. Set MTC Temperature Page 62

5. Set Alarm Limits Page 73

- **1.** Salinity Max. Limit
- **2.** Salinity Min. Limit
- **3.** Temperature Max. Limit
- **4.** Temperature Min. Limit
- **5.** Cell Constant Max. Limit
- **6.** Cell Constant Min. Limit

6. Timed Interval Readings Page 62

- **1.** On
  - **1.** Log to Memory
  - **2.** Log to Interface
  - **3.** Log to Memory and Interface
- **2.** Off

7. Select Data Transfer Mode Page 63

- **1.** Automatic Data Transfer
  - **1.** Log to Memory
  - **2.** Log to Interface
  - **3.** Log to Memory and Interface
- **2.** Manual Data Transfer to Memory

8. Activate Rondolino Sample Changer Page 63

- **1.** Measurement
- **2.** Calibration

9. Salinity Methods in Memory Page 64

- **1.** Load a Stored Method from Memory
- **2.** Save Current Settings as a Method

7.3.2 Operation of the Salinity menu

– If two expansion units are attached, first ensure that the desired expansion unit is selected.

– Press **Mode** and press **SAL** in the menu that appears to select the salinity mode.

– Call up the Salinity menu with **Menu**.

For practical reasons, the salinity of a solution is derived from the salinity of seawater. Two methods of calculating the salinity from the conductivity are supported.

The operation of the Salinity menu corresponds to that of the Conductivity menu except for item 1. Select Salinity Type and 5. Set Alarm Limits. A detailed description can be found in Section 7.1.2 Operation of the Conductivity menu on pages 58 to 65.

1. Select Salinity Type

1. Practical Salinity Scale (UNESCO 1978)

In the official definition, the salinity S_{psu} of a sample in psu (**p**ractical **s**alinity **u**nit) is calculated using the following formula at standard atmospheric pressure:

$$S = \sum_{j=0}^{5} a_j R_T^{j/2} - \frac{(T-15)}{1+k(T-15)} \sum_{j=0}^{5} b_j R_T^{j/2}$$

$a_0 = 0.0080$	$b_0 = 0.0005$	$k = 0.00162$
$a_1 = -0.1692$	$b_1 = -0.0056$	
$a_2 = 25.3851$	$b_2 = -0.0066$	
$a_3 = 14.0941$	$b_3 = -0.0375$	
$a_4 = -7.0261$	$b_4 = 0.0636$	
$a_5 = 2.7081$	$b_5 = -0.0144$	

$$R_T = \frac{C_{sample}(T)}{C_{KCl}(T)}$$ (32.4356 g KCl per 1000 g of solution)

2. Natural Sea Water Scale (UNESCO 1966b)

According to the older definition, the salinity S_{ppt} of a sample in ppt (**p**arts **p**er **t**housand) is calculated using the following formula for a temperature of T = 15 °C and at standard atmospheric pressure:

$$S_{ppt} = -0.08996 + 28.2929729\,R + 12.80832\,R^2 - 10.67869\,R^3 + 5.98624\,R^4 - 1.32311\,R^5$$

whereas

$R = C_{sample} / C$ with T = 15 °C

C_{sample} = conductivity of sample

C = 42.914 mS/cm Conductivity of Copenhagen Seawater Standard

If the conductivity is not measured at 15 °C, the following applies for 10 °C < T < 31 °C:

$R_T = C_{sample}(T) / C(T)$

$R = R_T + 10^{-5} R_T (R_T - 1)(T - 15) [96.7 - 72.0\,R_T + 37.3\,R_T^2 - (0.63 + 0.21\,R_T^2)(T - 15)]$

5. Set Alarm Limits

In this menu, you can define the upper and lower limits for measurement or calibration data. If a limit is exceeded or undershot, a warning is output to the screen. This message also appears on the GLP printout.

Before entering a limit, you can activate or deactivate the alarm for this limit.

Parameter	Minimum	Maximum	Unit
Salinity	0.00	80.00	ppt
Temperature	–30.0	130.0	°C
Cell Constant	0.000001	200.0	1/cm

7.3.3 Reading salinity

The salinity can be derived from the conductivity of a sample.

– Press **Mode** in the conductivity display.
– Activate conversion into salinity with **SAL**.
– Press **Menu** and select **1. Select Salinity Type**.
– Select salinity type and accept with **Select**.

The measurement is carried out as described in section 1 in the unit psu (practical salinity unit) or ppt (parts per thousand).

Note: If you change the conductivity sensor, a calibration **must** be performed because every sensor has its own cell constant and the calculation of the salt content of the sample is based on the cell constant. (For calibration see section 7.1.4 Calibrating a conductivity sensor)

– Attach a suitable conductivity sensor to the Conductivity expansion unit.
– If the conductivity sensor does not have a temperature sensor, enter the sample temperature manually (see Salinity Menu **4. Set MTC Temperature**).
– Place the conductivity sensor into the sample and press **Read**.
The salinity of the sample is shown on the display.

7.4 The Resistivity mode

7.4.1 Menu structure of the Resistivity mode

1. Measurement Setting Page 75

- **1.** Select Reference Temperature
- **2.** Select Temp. Correction Method
  - **1.** Linear Correction
  - **2.** Non-linear Correction: Natural Water
  - **3.** Off

2. Calibration Settings Page 60

- **1.** Set Calibration Standard
  - **1.** 10, 84, 500 & 1413 µS/cm, 12.88 mS/cm
  - **2.** Saturated NaCl
  - **3.** Enter Cell Constant during Calibration
  - **4.** Enter your Special Standard
- **2.** Set Calibration Reminder
  - **1.** Off
  - **2.** Remind by Interval Time

3. Select Endpoint Formats Page 61

- **1.** Auto
- **2.** Manual
- **3.** Timed

4. Set MTC Temperature Page 62

5. Set Alarm Limits Page 76

- **1.** Resistivity Max. Limit
- **2.** Resistivity Min. Limit
- **3.** Temperature Max. Limit
- **4.** Temperature Min. Limit
- **5.** Cell Constant Max. Limit
- **6.** Cell Constant Min. Limit

6. Timed Interval Readings Page 62

- **1.** On
  - **1.** Log to Memory
  - **2.** Log to Interface
  - **3.** Log to Memory and Interface
- **2.** Off

7. Select Data Transfer Mode Page 63

- **1.** Automatic Data Transfer
  - **1.** Log to Memory
  - **2.** Log to Interface
  - **3.** Log to Memory and Interface
- **2.** Manual Data Transfer to Memory

8. Activate Rondolino Sample Changer Page 63

- **1.** Measurement
- **2.** Calibration

9. Resistivity Methods in Memory Page 64

- **1.** Load a Stored Method from Memory
- **2.** Save Current Settings as a Method

7.4.2 Operation of the Resistivity menu

– If two expansion units are attached, first ensure that the desired expansion unit is selected.

– Press **Mode** and press **Res.** in the menu that appears to select the resistivity mode.

– Call up the Resistivity menu with **Menu**.

The operation of the Resistivity menu corresponds to that of the Conductivity menu except for items 1. Measurement Setting and 5. Set Alarm Limits. A detailed description can be found in Section 7.1.2 Operation of the Conductivity menu on pages 57 to 65.

1. Measurement Setting

1. Select Reference Temperature

You can select between the reference temperatures 20 °C and 25 °C. In the measurement, the resistivity of the sample is referenced to the selected temperature.

2. Select Temp. Correction Method

1. Linear Correction

The resistivity of a solution decreases with increasing temperature of the solution. With most solutions, an inverse linear relationship between resistivity and temperature is given. In such cases, select the linear correction method.

1. Enter Temp. Correction Coefficient

The input window for the temperature-correction coefficient (0 – 10 % / °C) appears.

The measured resistivity is corrected and displayed using the following formula:

$G_{TRef} = G_T / (1 + (\alpha(T - T_{Ref}))/100\ \%)$

whereas

G_T = resistivity measured at temperature T (mS/cm)

G_{TRef} = resistivity (mS/cm) displayed by the instrument, calculated back to the reference temperature T_{Ref}

α = linear temperature correction coefficient (%/°C); $\alpha = 0$: no temperature correction

T = measured temperature (°C)

T_{Ref} = Reference temperature (20 °C or 25 °C)

2. Determine Temp. Correction Coefficient

To determine the α coefficient, the sample has to be measured at two different temperatures.

– First measure the sample at a temperature that is different to that of the reference temperature and that is in the typical range of the sample temperature.

– Then measure the sample at the reference temperature.

– A window with the calculated value of α appears. Press **Save** to accept the value. If you exit the menu by pressing **Exit**, the result is discarded.

2. Non-Linear Correction: Natural Water

The conductivity of natural water shows strong non-linear temperature behaviour. For this reason, use the non-linear correction for natural water.

The measured conductivity is multiplied by the factor f_{25} for the measured temperature (see table in appendix) and thus corrected to the reference temperature of 25 °C:

$G_{T25} = G_T \cdot f_{25}$

If another reference temperature is to be used, e.g. 20 °C, the conductivity corrected to 25 °C is divided by 1.116 (see f_{25} for 20.0 °C)

$G_{T20} = (G_T \cdot f_{25}) / 1.116$

Note: Conductivity measurements of natural water can only be performed at temperatures ranging from 0 °C to 36 °C. Otherwise, the warning **Temp. out of nLF correction range** appears.

3. Off

If you switch off temperature correction, the conductivity value at the actual temperature is displayed (α = 0%/°C).

5. Set Alarm Limits

In this menu, you can define the upper and lower limits for measurement or calibration data. If a limit is exceeded or undershot, a warning is output to the screen. This message also appears on the GLP printout.

Before entering a limit, you can activate or deactivate the alarm for this limit.

Parameter	Minimum	Maximum	Unit
Resistivity	0.00	20.00	MΩ·cm
Temperature	–30.0	130.0	°C
Cell Constant	0.000001	200.0	1/cm

7.4.3 Reading resistivity

The resistivity is yielded from the reciprocal of the measured conductivity of the sample.

– Press **Mode** in the conductivity display.

– Activate conversion into resistivity [Ω·cm] with **Res.**.

Note: If you change conductivity sensor, a calibration **must** be performed because every sensor has its own cell constant and the calculation of the resistivity Is based on the cell constant. (For calibration see section 7.1.4 Calibrating a conductivity sensor).

– Attach a suitable conductivity sensor to the Conductivity expansion unit.

– If the conductivity sensor does not have a temperature sensor, enter the sample temperature manually (see Resistivity menu **4. Set MTC Temperature**).

– Place the conductivity sensor into the sample and press **Read**.
The resistivity of the sample is shown on the display.

8. Appendix

8.1 Technical data

8.1.1 Technical data of the SevenMulti™

Screen	LCD	
Outputs	RS232 serial Settable: baud rate (1200, 2400, 4800, 9600 baud), data bits (7, 8), stop bit (1, 2), parity (no, odd, even), Handshake (no, xon/xoff)	
	Analog output (with pH and Ion expansion unit only) Output impedance ≤ 10 kΩ	
Ambient conditions	Room temperature	5 °C ... 40 °C
	Relative humidity	80 % at 31 °C, decreasing linearly to 50 % at 40 °C
	Overvoltage category	II
	Degree of contamination	2
Dimensions	190 x 240 x 65 mm	
Weight	Basic device	850 g
	1 expansion unit	135 g
Power supply	The SevenMulti™ is equipped with a power supply adapter suitable for your area:	
	USA	120 V / 60 Hz, 10 VA, 9 V DC
	Europe	230 V / 50 Hz, 10 VA, 9 V DC
	UK	240 V / 50 Hz, 10 VA, 9 V DC
	Japan	100 V / 50/60 Hz, 10 VA, 9 V DC
Materials	Housing	ABS, reinforced with PC
	Expansion units	ABS, reinforced with PC
	Electrode arm	ABS, reinforced with PC
	Keypad	Polyester

8.1.2 Technical data of pH expansion unit

	pH	**mV**	**Temperature °C**
Measurement range	–2.000 ... 20.000	–1999.9 ... 1999.9	–30.0 ... 130.0
Resolution	0.001/0.01/0.1	0.1	0.1
Limits of error	± 0.002	± 0.1	± 0.1
Relative mV	–	yes	–
Temperature compensation	ATC	–5.0 °C ... 130.0 °C	
	MTC	–30.0 °C ... 130.0 °C	
Sensor input	Input impedance	≥ $3 \cdot 10^{12}$ Ω	
	Input offset current	≤ $1 \cdot 10^{-12}$ A	

8.1.3 Technical data of Conductivity expansion unit

Measurement range	Conductivity	0.001 µS/cm ... 1000 mS/cm	1.00E-6 ... 1.00E+2 S/m	
	TDS	0.01 mg/L ... 1000 g/L	Factor: 0.40 ... 1.00	
	Salinity	0.00 ... 80.00 ppt		
	Resistivity	0.00 ... 20.00 MΩ· cm		
	Temperature	–5 °C ... 130 °C		
Temperature compensation	ATC	–5 °C ... 130 °C		
	MTC	–30 °C ... 130 °C		
Measurement range/Resolution	Auto range		Scientific notation	
	–	–	5.00 … 9.99E–7 S/m	0.01E–7 S/m
	–	–	1.00 … 9.99E–6 S/m	0.01E–6 S/m
	–	–	1.00 … 9.99E–5 S/m	0.01E–5 S/m
	0.001 … 1.999 µS/cm	0.001 µS/cm	1.00 … 9.99E–4 S/m	0.01E–4 S/m
	2.00 … 19.99 µS/cm	0.01 µS/cm	1.00 … 9.99E–3 S/m	0.01E–3 S/m
	20.0 … 199.9 µS/cm	0.1 µS/cm	1.00 … 9.99E–2 S/m	0.01E–2 S/m
	200 … 1999 µS/cm	1 µS/cm	1.00 … 9.99E–1 S/m	0.01E–1 S/m
	2.00 … 19.99 mS/cm	0.01 mS/cm	1.00 … 9.99E+0 S/m	0.01E+0 S/m
	20.0 … 199.9 mS/cm	0.1 mS/cm	1.00 … 9.99E+1 S/m	0.01E+1 S/m
	200 … 1000 mS/cm	1 mS/cm	–	–
Limits of errors	± 0.5 % of measured value			
Analog output	Output impedance	≤ 20 kΩ		

8.1.4 Technical data of Ion expansion unit

Ion mode			
Measurement range	1.00E–9 ... 9.99E+9 mmol/l, mol/l, mg/l		
	0.001 ... 9999 ppm		
	0.001 % ... 999.9 %		
Resolution	± 1 of the least significant digit		
Limits of error	± 0.5 % of measured value		
Sensor input	Input impedance	≥ 3 · 10^{12} Ω	
	Input offset current	≤ 1 · 10^{-12} A	
Other modes	**pH**	**mV**	**Temperature °C**
Measurement range	–2.000 ... 20.000	–1999.9 ... 1999.9	–30.0 ... 130.0
Resolution	0.001/0.01/0.1	0.1	0.1
Limits of errors	± 0.002	± 0.1	± 0.1
Relative mV	–	yes	–
Temperature compensation	ATC	–5.0 °C ... 130.0 °C	
	MTC	–30.0 °C ... 130.0 °C	
Sensor input	Input impedance	≥ 3 · 10^{12} Ω	
	Input offset current	≤ 1 · 10^{-12} A	

8.1.5 Technical data of ISFET expansion unit

Measurement range pH	0.000 ... 14.000
Meas. range temperature	–5.0 °C ... 105.0 °C
Resolution	0.001 pH
Limits of errors	± 0.002 pH

8.2 Accessories

Designation	Order No.
pH expansion unit	51302821
Conductivity expansion unit	51302822
Ion expansion unit	51302823
ISFET expansion unit	51302824
Blank expansion unit	51302874
TTL communication module	51302825
Standard TTL cable	51190589
USB communication module (without cable)	51302826
Power supply EU	51302870
Power supply US	51302871
Power supply UK	51302872
Power supply JP	51302873
SevenMulti™ protective cover	51302819
Electrode arm, complete	51302820
Rondolino sample changer, complete	51108500
Compact stirrer, incl. 2 propeller stirrers	51109150
Seven/Rondolino Stirrer Driver (connection kit)	51302827
Disposable cups for Rondolino (1400 pieces)	101974
PowerShower™	51108219
Barcode reader Heron-G D130	21901297
Null modem adapter 9P M/M	21900924
Power cord for barcode reader EU	21901313
Power cord for barcode reader UK	21901314
Power cord for barcode reader US	21901315
Power cord for barcode reader AUS	21901316
RS cable F	21901305
Power supply 5V	21901311
Printer RS-P42	RS-P42
RS232 cable	51302125
Analog cable to titrators	51302258
LabX direct pH	51302876
Guide to pH measurement	51300047
Guide to conductivity and dissolved oxygen	51724716
Guide to ion selective measurement	51300075
pH 4.01 buffer, 30 packets at 20 mL each	51302069
pH 4.01 buffer, 6 bottles at 250 mL each	51340058
pH 7.00 buffer, 30 packets at 20 mL each	51302047
pH 7.00 buffer, 6 bottles at 250 mL each	51340060
pH 9.21 buffer, 30 packets at 20 mL each	51302070
pH 9.21 buffer, 6 bottles at 250 mL each	51300194
pH 10.01 buffer, 30 packets at 20 mL each	51302079
pH 10.01 buffer, 6 bottles at 250 mL each	51340231
InLab®410, pH electrode; temperature sensor; refillable	52000118
InLab®412, laboratory pH electrode; glass; refillable	52000112
InLab®413, robust pH electrode; PEEK shaft; ATC	52000100
InLab®420, pH electrode with PTFE polished diaphragm	52000113
InLab®730, laboratory conductivity electrode	51302119
InLab®740, conductivity sensor for low conductivity	51340260
InLab®490, laboratory ISFET electrode	51302305
InLab®501, Redox electrode with platinum ring	52000129

Designation	Order No.
HCl/pepsin solution (removes protein contamination)	51340068
Thiourea solution (removes silver sulfide contamination)	51340070
Reactivation solution for pH electrodes	51340073

8.3 Buffer groups

Buffer group 1 (ref. 25 °C) METTLER TOLEDO US

5	1.67	4.01	7.09	10.25
10	1.67	4.00	7.06	10.18
15	1.67	4.00	7.04	10.12
20	1.68	4.00	7.02	10.06
25	**1.68**	**4.01**	**7.00**	**10.01**
30	1.68	4.01	6.99	9.97
35	1.69	4.02	6.98	9.93
40	1.69	4.03	6.97	9.89
45	1.70	4.04	6.97	9.86
50	1.71	4.06	6.97	9.83

Buffer group 2 (ref. 25 °C) METTLER TOLEDO Europe

5	2.02	4.01	7.09	9.45	11.72
10	2.01	4.00	7.06	9.38	11.54
15	2.00	4.00	7.04	9.32	11.36
20	2.00	4.00	7.02	9.26	11.18
25	**2.00**	**4.01**	**7.00**	**9.21**	**11.00**
30	1.99	4.01	6.99	9.16	10.82
35	1.99	4.02	6.98	9.11	10.64
40	1.98	4.03	6.97	9.06	10.46
45	1.98	4.04	6.97	9.03	10.28
50	1.98	4.06	6.97	8.99	10.10

Buffer group 3 (ref. 20 °C) Merck standard buffers

5	2.01	4.04	7.07	9.16	12.41
10	2.01	4.02	7.05	9.11	12.26
15	2.00	4.01	7.02	9.05	12.10
20	**2.00**	**4.00**	**7.00**	**9.00**	**12.00**
25	2.00	4.01	6.98	8.95	11.88
30	2.00	4.01	6.98	8.91	11.72
35	2.00	4.01	6.96	8.88	11.67
40	2.00	4.01	6.95	8.85	11.54
45	2.00	4.01	6.95	8.82	11.44
50	2.00	4.00	6.95	8.79	11.33

Buffer group 4 (ref. 25 °C) DIN (19266) / NIST

5	1.668	4.004	6.950	9.392	13.207
10	1.670	4.001	6.922	9.331	13.003
15	1.672	4.001	6.900	9.277	12.810
20	1.676	4.003	6.880	9.228	12.627
25	**1.680**	**4.008**	**6.865**	**9.183**	**12.454**
30	1.685	4.015	6.853	9.144	12.289
35	1.691	4.026	6.845	9.110	12.133
40	1.697	4.036	6.837	9.076	11.984
45	1.704	4.049	6.834	9.046	11.841
50	1.712	4.064	6.833	9.018	11.705

Buffer group 5 (ref. 25 °C) DIN (19267)

5	1.08	4.67	6.87	9.43	13.63
10	1.09	4.66	6.84	9.37	13.37
15	1.09	4.66	6.82	9.32	13.16
20	1.09	4.65	6.80	9.27	12.96
25	**1.09**	**4.65**	**6.79**	**9.23**	**12.75**
30	1.10	4.65	6.78	9.18	12.61
35	1.10	4.65	6.77	9.13	12.45
40	1.10	4.66	6.76	9.09	12.29
45	1.10	4.67	6.76	9.04	12.09
50	1.11	4.68	6.76	9.00	11.98

Buffer group 6 (ref. 25 °C) JJG 119 (Chinese)

5	1.669	3.999	6.949	9.391	13.210
10	1.671	3.996	6.921	9.330	13.011
15	1.673	3.996	6.898	9.276	12.820
20	1.676	3.998	6.879	9.226	12.637
25	**1.680**	**4.003**	**6.864**	**9.182**	**12.460**
30	1.684	4.010	6.852	9.142	12.292
35	1.688	4.019	6.844	9.105	12.130
40	1.694	4.029	6.838	9.072	11.975
45	1.700	4.042	6.834	9.042	11.828
50	1.706	4.055	6.833	9.015	11.697

Buffer group 7 (ref. 25 °C) Technical Buffer

5	2.02	4.01	7.09	10.65
10	2.01	4.00	7.06	10.39
15	2.00	4.00	7.04	10.26
20	2.00	4.00	7.02	10.13
25	**2.00**	**4.01**	**7.00**	**10.00**
30	1.99	4.01	6.99	9.87
35	1.99	4.02	6.98	9.74
40	1.98	4.03	6.97	9.61
45	1.98	4.04	6.97	9.48
50	1.98	4.06	6.97	9.35

Buffer group 8 (ref. 25 °C) JIS Z 8802 (Japanese)

5	1.668	3.999	6.951	9.395	
10	1.670	3.998	6.923	9.332	
15	1.672	3.999	6.900	9.276	
20	1.675	4.002	6.881	9.225	
25	**1.679**	**4.008**	**6.865**	**9.180**	
30	1.683	4.015	6.853	9.139	
35	1.688	4.024	6.844	9.102	
40	1.694	4.035	6.838	9.068	
45	1.700	4.047	6.834	9.038	
50	1.707	4.060	6.833	9.011	

8.4 Temperature-correction factors f_{25}

°C	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0	1.918	1.912	1.906	1.899	1.893	1.887	1.881	1.875	1.869	1.863
1	1.857	1.851	1.845	1.840	1.834	1.829	1.822	1.817	1.811	1.805
2	1.800	1.794	1.788	1.783	1.777	1.772	1.766	1.761	1.756	1.750
3	1.745	1.740	1.734	1.729	1.724	1.719	1.713	1.708	1.703	1.698
4	1.693	1.688	1.683	1.678	1.673	1.668	1.663	1.658	1.653	1.648
5	1.643	1.638	1.634	1.629	1.624	1.619	1.615	1.610	1.605	1.601
6	1.596	1.591	1.587	1.582	1.578	1.573	1.569	1.564	1.560	1.555
7	1.551	1.547	1.542	1.538	1.534	1.529	1.525	1.521	1.516	1.512
8	1.508	1.504	1.500	1.496	1.491	1.487	1.483	1.479	1.475	1.471
9	1.467	1.463	1.459	1.455	1.451	1.447	1.443	1.439	1.436	1.432
10	1.428	1.424	1.420	1.416	1.413	1.409	1.405	1.401	1.398	1.384
11	1.390	1.387	1.383	1.379	1.376	1.372	1.369	1.365	1.362	1.358
12	1.354	1.351	1.347	1.344	1.341	1.337	1.334	1.330	1.327	1.323
13	1.320	1.317	1.313	1.310	1.307	1.303	1.300	1.297	1.294	1.290
14	1.287	1.284	1.281	1.278	1.274	1.271	1.268	1.265	1.262	1.259
15	1.256	1.253	1.249	1.246	1.243	1.240	1.237	1.234	1.231	1.228
16	1.225	1.222	1.219	1.216	1.214	1.211	1.208	1.205	1.202	1.199
17	1.196	1.193	1.191	1.188	1.185	1.182	1.179	1.177	1.174	1.171
18	1.168	1.166	1.163	1.160	1.157	1.155	1.152	1.149	1.147	1.144
19	1.141	1.139	1.136	1.134	1.131	1.128	1.126	1.123	1.121	1.118
20	1.116	1.113	1.111	1.108	1.105	1.103	1.101	1.098	1.096	1.093
21	1.091	1.088	1.086	1.083	1.081	1.079	1.076	1.074	1.071	1.069
22	1.067	1.064	1.062	1.060	1.057	1.055	1.053	1.051	1.048	1.046
23	1.044	1.041	1.039	1.037	1.035	1.032	1.030	1.028	1.026	1.024
24	1.021	1.019	1.017	1.015	1.013	1.011	1.008	1.006	1.004	1.002
25	1.000	0.998	0.996	0.994	0.992	0.990	0.987	0.985	0.983	0.981
26	0.979	0.977	0.975	0.973	0.971	0.969	0.967	0.965	0.963	0.961
27	0.959	0.957	0.955	0.953	0.952	0.950	0.948	0.946	0.944	0.942
28	0.940	0.938	0.936	0.934	0.933	0.931	0.929	0.927	0.925	0.923
29	0.921	0.920	0.918	0.916	0.914	0.912	0.911	0.909	0.907	0.905
30	0.903	0.902	0.900	0.898	0.896	0.895	0.893	0.891	0.889	0.888
31	0.886	0.884	0.883	0.881	0.879	0.877	0.876	0.874	0.872	0.871
32	0.869	0.867	0.866	0.864	0.863	0.861	0.859	0.858	0.856	0.854
33	0.853	0.851	0.850	0.848	0.846	0.845	0.843	0.842	0.840	0.839
34	0.837	0.835	0.834	0.832	0.831	0.829	0.828	0.826	0.825	0.823
35	0.822	0.820	0.819	0.817	0.816	0.814	0.813	0.811	0.810	0.808

8.5 Conductivity standards

T (°C)	10 µS/cm	84 µS/cm	500 µS/cm	1413 µS/cm	12.88 mS/cm	Saturated NaCl mS/cm
5	6.13	53.02	315.3	896	8.22	155.5
10	7.10	60.34	359.6	1020	9.33	177.9
15	7.95	67.61	402.9	1147	10.48	201.5
20	8.97	75.80	451.5	1278	11.67	226.0
25	**10.00**	**84.00**	**500.0**	**1413**	**12.88**	**251.3**
30	11.03	92.19	548.5	1552	14.12	277.4
35	12.14	100.92	602.5	1667	15.39	304.1

8.6 USP / EP tables

Conductiviy requirements (µS/cm) for USP / EP (highly purified water) / EP (purified water)

Temperature [°C]	USP [µS/cm]	EP (highly purfied water) [µS/cm]	EP (purified water) [µS/cm]
0	0.6	0.6	2.4
5	0.8	0.8	—
10	0.9	0.9	3.6
15	1.0	1.0	—
20	1.1	1.1	4.3
25	1.3	1.3	5.1
30	1.4	1.4	5.4
35	1.5	1.5	—
40	1.7	1.7	6.5
45	1.8	1.8	—
50	1.9	1.9	7.1
55	2.1	2.1	—
60	2.2	2.2	8.1
65	2.4	2.4	—
70	2.5	2.5	9.1
75	2.7	2.7	9.7
80	2.7	2.7	9.7
85	2.7	2.7	—
90	2.7	2.7	9.7
95	2.9	2.9	—
100	3.1	3.1	10.2

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